Tampere University of Applied Sciences

Lighting As A Service

Cash Flow Analysis For Technology Manufacturers

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ABSTRACT

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Cash Flow Analysis for Technology Manufacturers

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ARA is a start-up in the City of Munich, Germany with its mission being to promote the transition to a circular economy in manufacturing with modular lighting technology solutions through an “As-a-Service” model. This thesis was carried out as a case study for the ARA team.

The objective of the thesis was to discover potentials of servitization and service contracts in manufacturing. The study aimed to cast light on opportunities and barriers that manufacturers will face when they become a partner with ARA in order to provide modular lighting systems. Further, the impact of servitization on a firm's financial performance was investigated and subsequently used to develop a calculation toolkit for a manufacturer on a ceteris paribus basis.

The theoretical framework explores concepts of servitization, service classification, product as a service and servitization process. The data was collected from 6 individual interviews in the lighting industry and analyzed by applying the content analysis technique of qualitative research methodology.

Key findings showed that services had been recognized as a means of creating new values and maintaining long-term customer relationships. The majority of interview participants believed that servitization was a new notion and had unbound potentials to create a new business model with sustainable values and innovations. This is critical as modern consumers and governments increasingly demand solutions associated with sustainable development.

A financial analysis in the form of a calculation toolkit was carried out to support the feasibility of servitization. The results suggest that a manufacturer’s cash flow would be discounted due to inflation rate during the service contract. However, the company could promisingly obtain a high revenue if the product maintained its high level of durability and low failure rate throughout its lifecycle.

Further research is needed to produce a comprehensive picture of servitization in manufacturing. It should be also noted that basic financial knowledge and skills are required to employ the calculation toolkit successfully.

Key words: product as a service, servitization, financial toolkit

CONTENTS

1 INTRODUCTION

Kraaren (2016) states that the second Industrial Revolution in the late 19th century sparked the adoption of new production practices. Thereafter, global manufacture is dominated by the linear 'take, make, dispose' model, in which raw materials are utilized in manufacturing systems and then ultimately discarded as waste. However, new studies have questioned the sustainability of the current linear economy. Miret (2014) finds that the linear production model has exerted increasing pressure on manufacturers due to the augmented costs of obtaining basic raw materials from limited resource deposits. Kraanen (2016) also supports that if the current production practices and consumption patterns persist with linear economic principles, it will potentially lead to substantial shortages of certain resources, emergent price volatility, and continued environmental degradation. As a natural development, many traditional manufacturers have shifted from linear into circular business models in recent years.

In addition to the circular economy megatrend, for the past several decades, modern technologies have enabled a global transition from traditional product manufacturing models to flexible consumption models (FCMs), known as "As-a-Service" (Arora et al., 2018). According to their report, products are purchased and consumed as a service in FCMs, which will give firms competitive advantages such as steady revenue streams and lower operational costs. Newman (2017) supports the "As-a-Service" models by saying that they often require a less demanding upfront investment on infrastructure and offer a greater range of flexibility to adapt the services to market demand than its product-centric counterparts. The process of transformation from the product- to service-oriented business model is called "servitization" (Euchner & Baines, 2014).

This thesis is a case study on a start-up named ARA that offers modular lighting technology solutions as a service in the City of Munich, Germany. Through interviews with equipment manufacturers and literature reviews, this paper shall reinforce the "As-a-Service" model in the lighting industry, especially with regard to the financial performance. The following sections shall provide a deeper insight into the theoretical framework of the thesis.

2 THEORETICAL FRAMEWORK

2.1 Thesis objectives, purposes and research questions

The primary objective of the thesis is to examine the benefits and disadvantages of servitization for product-centric manufacturers. Through qualitative research, the thesis aims to support ARA's "As-a-Service" model in the lighting industry. The project is expected to acknowledge the potentials of outcome-based service contracts and practicability of this offering in the EU market. In addition, a manufacturing firm's financial performance will be investigated when its revenue stream shifts from conventional product sales to the Product-as-a-Service (PaaS) model, from which a multitude of financial analysis tools will be developed. The toolkit is designed to allow the manufacturers to evaluate the financial gains of utilizing the "As-a-Service" model in lieu of the product-centric paradigm, based on ceteris paribus basis.

Settled by the researcher and thesis commissioner, the financial toolkit should meet the basic requirements as below:

- It is built in Excel Workbooks (.xlsx) or Google Spreadsheet;
- It is user-friendly, informative, and practical;
- It is based on logical financial theories and methods;
- It draws a fair comparison between the conventional sales distribution and ARA distribution model with a certain contract term;
- It produces a dynamic analysis of business performance.

The thesis has a strategic purpose of supporting ARA in business development. After the first pilot project, the start-up plans to scale up and grow the partner network in other EU Member States, apart from Germany. In addition to the pitch and prototype, the team is currently searching for a tool that could illustrate the financial gains of the ARA's "As-a-Service" distribution model for the lighting technology manufacturers. Qualitative research on the topic will serve as a material to present the business value propositions and the service-contract opportunities more convincingly.

The thesis aims to answer the following questions:

1. Main question: How promising is the “As-a-Service” model from the financial perspective of manufacturers?
2. Sub-questions:
    - What are the opportunities and challenges that the “As-a-Service” model potentially brings to the manufacturers?
    - How can lighting manufacturers' cash flow be represented with a financial analysis toolkit?

2.2 Concepts and Theories

2.2.1 Servitization

Manufacturing in industrialized nations adopts services more intensively and the share of services in total turnover is on the rise (Lodefalk, 2014). In spite of an increasing adoption for several decades, the concept of servitization has not been clearly defined and understood by many industrial actors but is “rather nuanced and subtle” (Baines, 2014).

Servitization can be construed as a shift from products to services (Gebauer & Binz, 2018). According to Kowalkowski et al. (2017), servitization can be defined as the transformational procedures whereby a company shifts its business model and logic from being product-centric to service-oriented. They note that servitization covers service infusion, which is the process whereby the overall role of service-based offerings in a company or business unit gets more important and augment its service business orientation (SBO).

Baines et al. (2017) emphasize that servitization has coalesced into “a process of building revenue streams for manufacturers from services.” In some other contexts, “servitization” can be used interchangeably with other terms such as “product service systems (PSS)”, “eco-efficient services”, or “functional sales” (Plepys et al., 2015). Within the context of this thesis, the concept of servitization refers to the process of selling the product’s function in lieu of the material product itself to encourage sustainable production and consumption in the circular economy.

2.2.2 Service classification

In a study of Baines et al. (2013), services offered by a manufacturing firm are classified into three levels: Base, Intermediate, and Advanced, each of which has different principles of focus, operational range, risk level, and revenue stream. The service classification is further presented in Table 1.

TABLE 1. Meta-clustering of service offerings (Baines et al., 2013)

	Principle on which cluster is defined	Relative characteristics of cluster			Examples of services offerings within cluster
		Range of service activities	Extent of risk	Revenue payment	
Base services	Focus on product provision	Narrow: activities centred on and around production competences	Low: easily delivered for an enterprise with manufacturing competences	Point: largely on completion of contract	Product/ equipment provision, spare part provision
Intermediate services	Focus on condition maintenance	Broadening: based on the exploitation of production competences to assure state and condition of equipment	Medium: increased expose to the consequences of equipment faults	Periodic: some upfront and/or on completion. Maybe with interim payments	Scheduled maintenance, technical help-desk, repair, overhaul, delivery to site, operator training, condition monitoring, in-field service
Advanced services	Focus on outcome assurance	Extended: stretching the manufacturing enterprise to take on activities that are usually internal to the customer	High: financial penalties incurred almost immediately if equipment fails to perform as specified	Linear: pay-through-use with period adjustments in rate	Customer support agreement, risk and revenue sharing contract, revenue-through-use contact, rental agreement

The classification system in Table 1 shows that manufacturing firms can provide a variety of different service forms: based offerings, intermediate offerings and advanced offerings.

- Based offerings, such as storage and delivery services, mainly support product provision with narrow actions and small risks
- Intermediate offerings aim to enhance the supply chain, process control and product status during the distribution procedure.
- Advanced offerings such as third-party outsourcing and consultancy are customized, involve more risks, and hence require greater management efforts. This thesis will observe the adoption of advanced services whereby “a manufacturer sells the benefits of product consumption rather than the product itself” (Euchner & Baines, 2014).

2.2.3 Product as a service (PaaS)

Bigelow (2017) states that “as-a-service”, known as XaaS, is an umbrella term for the delivery of anything as a service through a common platform, typically the Internet. The most common applications of XaaS include Software as a service (SaaS), Platform as a service (PaaS) and Infrastructure as a service (IaaS). Arora et al. (2018, 2) believe that XaaS supports flexible consumption models with a wide range of payment and delivery methods to meet the user’s needs.

Another benefit thereof, according to Hyun & Kim (2021), is that servitization has been proved to generate stable cash flows and diversify revenue streams, which give advantages in economic downturns. As a result, more and more production firms in industrial sectors strive for growth beyond their core product by adopting a service transition strategy and creating a new service-based business model: Product as a service (PaaS).

Quijano (2020) defines product-as-a-service as a bundle of offerings that amalgamate products and services together through subscription. Companies of this business model will market their products with a regular repayment, which come included with service contracts of maintenance, upgrade, and/or replacement, inter alia. In academic research, product as a service (PaaS) is regarded as Product-Service Systems (PSS) (Kowalkowski et al., 2017; Baines et al., 2017; Baines et al., 2013)

2.2.4 Servitization process

In recent years, many research efforts have been made to find a well-established transformation framework and methodologies for adopting PSS-based solutions (Baines et al., 2020). Taking a bottom-up approach to simplify the PSS complexities and uncertainties, Farsi & Erkoyuncu (2020) developed a conceptual design of the servitization process. Their model is illustrated in Figure 1.

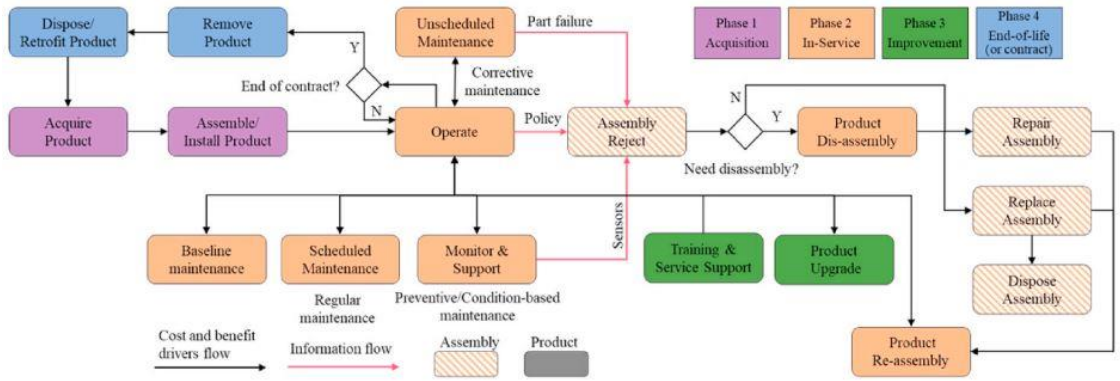

FIGURE 1. A generic PSS cost-benefit conceptual model for service providers

According to Figure 1, the generic conceptual design by Farsi & Erkoyuncu (2020) considers four stages in the service and product lifecycle over the period of the servitization contract to weigh the costs and benefits in the PSS model. The primary phase “acquisition” includes two steps – product purchase and installation, to render the product operational. Notedly, this state involves costs and benefits of the procurement in a service agreement. The second phase is called “In-service” and consists of operation, maintenance, monitor, and support efforts to ensure the availability of the product in service. In the next phase “Improvement”, product upgrade, training, and service support will be provided to have optimal service solutions. Costs and benefits in these stages should be planned circumspectly as productivity, quality and precision are equally critical as functionality, performance and availability in outcome-oriented contracts. When the service agreement expires, the product will be disassembled and assessed for after-consumption plans such as retrofit, recycle, and reuse.

2.3 Research methodology

2.3.1 Qualitative research

Qualitative research is an umbrella term for a wide array of approaches and methods for studies in humanities and social sciences. Qualitative data primarily, but not exclusively, takes the form of non-numeric characters: textual materials such as interview transcripts, field notes, academic journals and articles; or visual materials such as artefacts, photographs, video recordings (Saldana, 2011). In a qualitative study, data is collected through one or more of the following methods: observations with field notes, interviews, focus groups, surveys with open-ended questions, and secondary research.

The research will follow the qualitative study design for two main reasons. First, the company is in its infancy and therefore does not have enough resources to obtain reliable samples for quantitative methods. A qualitative study is more desirable because the ARA team can gain insights on the partners' opinions on the servitization concept, supported by literature reviews, theoretical frameworks, and business journals. In addition thereto, since the expected outcome is to provide the start-up team with exploratory results that can be used in the future, qualitative methods are preferable for this work. Specifically, the work aims to develop a set of tools for financial analysis when lighting companies service their products through the ARA "As-a-Service" model.

2.3.2 Data collection strategy

In this thesis, empirical data will be collected from individual interviews with ARA's partner representatives who act as product managers, sustainability managers, project developers, financial managers or operations managers. The interviews are conducted online and in English or German translated into English language. The interviews have a semi-structured design wherein the interviewer poses the questions as an usual conversation and allows the participants to diverge and express their ideas more dynamically. Unlike structured interviews, this approach

offers a higher level of flexibility because the interviewees are free to elaborate upon their answer and disclose their underlying beliefs (Gill et al., 2008).

Primary data will be also referenced from ARA's unpublished business plan, own observations, and meeting notes. In addition to the aforementioned data sources, secondary data will be gathered from scientific journals, business publications, and literature reviews that approach the topic conferred. Utilization of resources in the Tampere Universities' libraries and the digital material bank Andor will be maximized in this thesis.

2.3.3 Data management and analysis

Because of the non-numerical nature, data in this thesis will be analyzed by the content analysis technique. It is the most common practice in qualitative research by which researchers interpret documents: field notes, interview responses, messages, books, media and other similar forms of communication. Content analysis is generally divided into two types: conceptual analysis and relational analysis. Conceptual analysis examines the existence and frequency of concepts in textual information. Relational analysis follows the same steps in the conceptual analysis but further explores the relationships among concepts. Each analytical type could produce different results, interpretations and conclusions. This thesis will mainly carry out a conceptual analysis for interview contents.

2.4 Thesis structure

The thesis includes 6 main chapters. Chapter 1 is an introductory section that provides general knowledge of circular economy, and the globally growing trend of "As-a-service" models. Chapter 2 provides a comprehensive explanation of the research plan with 4 main points:

- Section 2.1 clarifies thesis objectives, purposes and research questions.
- Section 2.2 presents the theoretical framework, in which concepts of servitization, service classification, product as a service (PaaS) and servitization process will be explained.

- Section 2.3 specifies the research methodology.
- Section 2.4 outlines the structure of the thesis.

Chapter 3 provides details of the case study: ARA. The start-up is described with respect to mission, vision, business model and current state. Chapter 4 presents an analysis of the interview results on two topics: services and servitization, and financial concerns regarding servitization. Chapter 5 discusses (i) underlying trends behind servitization, (ii) value creation through servitization and introduces a cash flow analysis toolkit for manufacturers in the “As-a-Service” model. The limitations of this research are also discussed in this chapter. As the final part, Chapter 6 delivers the conclusions, followed by references and appendices used in this thesis.

3 ARA START-UP

3.1 Mission, vision and company form

ARA is a start-up whose statutory seat is located in the City of Munich, Germany. The start-up has been established in the form of an entrepreneurial company with limited liabilities (in German: Unternehmergesellschaft (haftungsbeschränkt)), which is suitable for start-up company as it only requires 1 euro of initial capital to establish (Sec. 5a GmbHG - Gesellschaft mit beschränkter Haftung Gesetz - German law on limited liabilities companies).

With its mission being to support the transition to a circular economy in the real estate industry, ARA is committed to sustainable and modular lighting solutions as a service. More specifically, they lease technical building equipment, consisting of but not limited to LED modules and sensors to building owners and property developers. The company's vision is to become a service platform for sustainable property technologies that allow buildings and facilities to benefit from digitalization and enhanced energy efficiency.

3.2 Business model

Figure 2 presents the business model of ARA. The first ARA's innovation is a modular system for lighting and sensor, network, and safety equipment. Products of different manufacturers altogether form a modular construction kit. The modularity and compatibility thereof is realized by predefined mechanical interfaces. Technologies offered by ARA are modifiable and repairable as a unique selling point, because every single component can be disassembled, exchanged, and upgraded. In addition, ARA provides a return guarantee for all elements to ensure that their products will be collected, dismantled, evaluated, and recycled by value after consumption.

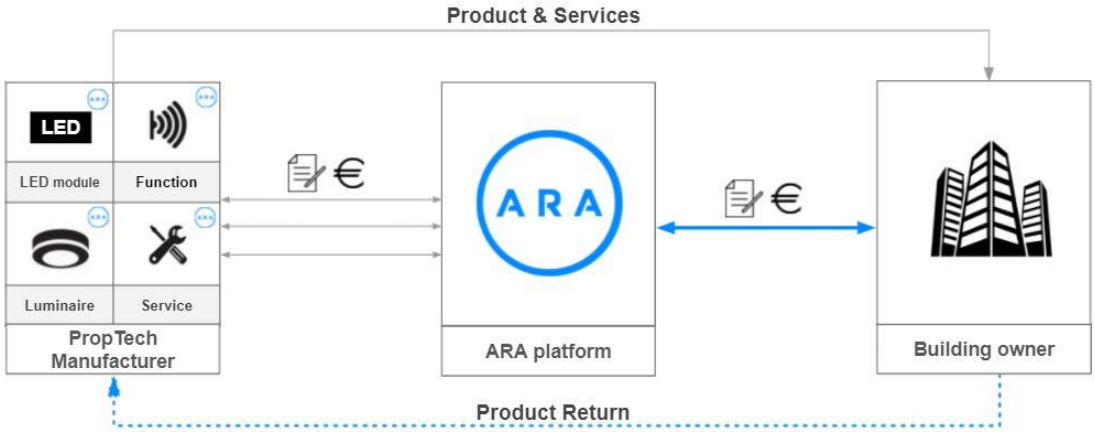

FIGURE 2. ARA Business Model

As the second innovation, ARA will be a service platform for the rental of technical building equipment. In other words, ARA does not manufacture any product but operates as a service contractor between building owners and equipment manufacturers. Therefore, there is no transfer of ownership during the contractual period. The products are under the ownership of the manufacturers who are responsible for exchange and update services.

3.3 Current state

ARA is currently in the phase of market development. In conjunction with other lighting manufacturers, they pilot a project for Siemens in Perlach, Munich. Some efforts such as participation in startup programs and trade fairs to increase brand awareness have been planned and executed. Moreover, ARA team is planning to develop a partnership network to diversify the portfolio and have larger scale projects in 2022.

4 DATA ANALYSIS

Six individual interviews were done to collect opinions from lighting technology manufacturers. The contents thereof focused on the role of services and the servitization concept regarding their opportunities and challenges. Special attention was given to firms' concerns on servitization within the scope of financial performance. This chapter shall provide an analysis of the obtained data.

4.1 Services and servitization

The interview findings reveal that lighting manufacturers have started to provide services that accompany their product line. There is a substantial complexity and customization variance in their offerings, which are tied into the end user's needs. These needs fall into the service meta-cluster model proposed by Baines et al. (2013). A summary of services offered by the companies participated in the interviews can be found in Table 2 as below.

TABLE 2. Services provided by ARA's partners

Company	Industry	Services
Hekatron	Emergency power systems	Planning Training and consulting Product installation Product delivery Maintenance inspection softwares
Gessler GmbH	Lighting (Luminaires), emergency power systems	Building Planning Maintenance
Vossloh Schwabe	Lighting (LED)	Softwares
Tridonic	Lighting (LED)	Softwares Data services
Siteco	Lighting (Luminaires)	Installation (carried out by partner) Maintenance Lighting audit
Enlighted	Sensor	Softwares Data services Sensoring as a service

As per Table 2, basic services commonly offered by lighting technology manufacturers include installation and delivery of products, which could be outsourced to third-parties. This is to allow the company to focus on enhancing product quality and their competency. Some lighting equipment providers have offered intermediate-level services for a wide range of purposes from planning, manufacturing to controlling, monitoring, and repairing. Lighting vendors maintain their competitiveness with services that are not only innovative and comply with latest legislation, but also bring about sustainable values in production and consumption. For instance, Siteco offers lighting audit[1] that helps building owners to use energy more efficiently and to keep abreast of industry standards.

[1] Lighting audit is a procedure to assess facility energy consumption against environmental standards in order to determine essential changes, so that the company can stay compliant with the current laws or fulfil their corporate social responsibilities (FSG Electric & Lighting, 2019).

Nevertheless, no company interviewed is yet to heavily rely on these services as their main profit center. In fact, services only account for under 20% of the total revenues, according to their annual reports stated by over half of the business representatives. These services are gratuitous, because they are covered by product purchases, as they are meant to render non-pecuniary gains.

When being inquired about the role of services, all equipment manufacturing firms express a positive outlook. They realize the benefits of service offerings by adding unique values to gain competitive advantages and sustainability. “In a competitive world, customers especially demand quality and services because they are more concerned about environmental and social impacts of products and production.”, said by Enlighted representative. 75% of respondents also consider services as a means of “attracting new customer segments” with “diverse needs”, whereby it “increas[es] market share”.

With respect to sustainability, the majority of interviewed companies agree that modularity is a growing movement driven by the industrial transition into a circular economy (see Appendix 1). “I am certain that luminaires will be modular, and products will be interchangeable in the future. Through scaling up, companies can reduce or eliminate costs on R&D, administration, and warehousing.”, said by the business representative from Siteco.

Furthermore, nearly all interviewees agree that technological adoption has been common across industries as a direct result of the Industrial Revolution 4.0, and “As-a-Service” models are emerging in the lighting industry. Some equipment companies have offered “data as a service” and “software as a service” that help customers keep track of the product performance with metrics such as carbon dioxide consumption or luminous efficacy. These innovative models and offerings have been dynamically tested and validated by several firms in recent years. More than 80% of interview participants believe that advanced technologies will generate more services in the future.

On the other hand, there remains legitimate skepticism from some manufacturers concerning servitization for a plethora of reasons. First, working on modular so-

lutions could yield a manufacturer economically overdependent on other component providers and more susceptible to risks and conflicts stemming from the network. For instance, channel conflicts, which arise from individual actions that jeopardize or delay the objectives of other businesses or partners, can occur throughout the value chain between manufacturers and wholesalers, suppliers, retailers, and inter alia. A great number of business representatives consider such risks as an unfavorable threat not only to the main activity of each company, but also the entire network.

In addition, despite the notion that product modularity could render sustainable solutions, some manufacturers are skeptical about the feasibility of modular technologies due to the lack of regulations. Cooperating with other companies requires having shared goals and agreement on how the risks and profits will be shared among parties. In this respect, it is challenging to compose service contracts that concern many companies and are undoubtedly undesirable to tackle conflicts of interest. These business representatives also assert that it will take a significant amount of time for governments, unions and organizations to define a standard legal framework for the “As-a-Service” model.

Last but not least, a minority of the interviewed manufacturers express concerns about product design and compatibility, as well as the lack of qualified personnel for servitization due to an absence of an established framework. Offering modular solutions with various component partners requires an effort to have an optimal product design with a standard level of compatibility and durability. As the process is not straightforward and involves a lot of stakeholders, some firms consider servitization as an undesirable pressure on skilled labor and customer service.

4.2 Financial concerns of servitization

The findings show that finances have been a major concern to the manufacturers in servitization, when all the interviewees inquired a multitude of elements of sales and financial statements. The data was analyzed according to the following benchmarks: (i) sales growth, (ii) revenues, (iii) costs, (iv) profitability, (v) break-even point and (vi) payback period.

4.2.1 Sales growth

All interviewed manufacturers raise a question whether servitization for modular lighting technologies will have negative or positive effects on their annual sales and sales growth. Despite potential opportunities to diversify sales channels, the “As-a-Service” model might create a growing competition among companies and cooperation networks for products with similar features – a phenomenon called sales cannibalization. Channel conflicts might confuse the customers, who must take into account the value added of all the alternatives in terms of price, quality, and convenience in the process of decision making.

In addition, over half of the interviewees speculate that shifting to servitization will call for a new service organization and culture. This translates to the company must implement a change managerial procedure which could be costly and challenging. With respect thereto, the interviewees mention a great number of obstacles, such as resources allocation, prioritization of work, absence of expert support, and reluctance to a new problem-solving approach. This situation could result in internal confusion, tension or conflict among company divisions. These conflicts might negatively influence staff motivation and performance, which will in turn undermine the values of a company.

4.2.2 Revenues

Likewise, almost all companies in the interview convey great concerns about the impact of servitization on their revenues. This is due to the fact that adoption thereof may alter their revenue stream. In the “As-a-Service” model, customers consume the product and pay a periodical fee for the consumption in lieu of a one-off payment. Consequently, the subscription model will scatter the revenues over the contract period that might be up to years. On the other hand, there is a consensus amongst interviewees that the business will receive a stable income stream from leasing the product instead of one-time payment as the conventional selling method. Notwithstanding, they are concerned that the lack of one single aggregated payment might lead to financial issues caused by lack of liquidity. The

income annuity as per “As-a-Service” model might also be susceptible to the changes in interest rate.

4.2.3 Costs

Following the previous concern, some manufacturers question how servitization can ensure that they can cover the standard cost for a unit of product. In manufacturing, standard costs, also known as cost of goods sold, include expenses on direct materials, direct labor and manufacturing overhead charges. Direct costs are the costs that can be directly allotted to one production unit, which includes the raw input material as well as per hours wages expenses for labor. Manufacturing overhead consists of indirect costs such as facility rent and property taxes. In addition, manufacturers might have to bear responsibility for replacing or updating products under the service contract, hence questioning the possibility to cover additional costs.

4.2.4 Profitability

Profitability is arguably the most important indicator of a business. When considering servitization from this perspective, all the manufacturers' representatives are significantly concerned that “As-a-Service” theory will negatively impact their annual profits due to interest rate and inflation. They state that the cash flow would be discounted due to inflation when revenues are collected periodically over the service contract. Furthermore, all interview participants mention the apprehension of how servitization will affect profit margin and profit curve. They are skeptical about their annual profitability in initial years when the company has not reached the break-even point yet.

4.2.5 Break-even point

Furthermore, some business representatives would like to see the break-even point of their sales in the “As-a-Service” model. Nearly 80% of the interviewees

agree that the break-even point is a critical figure that presents the level of production at which revenues will cover operational costs, which are standard costs in manufacturing.

4.2.6 Payback period

Beyond the break-even point, manufacturers want to know the payback period, which refers to the time it takes to recoup initial investment costs and reach the break-even point. More than 60% of the interviewees consider this as a significant factor in project evaluation. In general, long payback periods are less desirable and short payback periods are more appealing.

5 DISCUSSION

With the previous interview results in Chapter 4, this Chapter shall provide a detailed insight into these two following aspects: (i) underlying trends behind servitization and (ii) value creation in servitization. This part shall also propose a calculation toolkit for manufacturers to evaluate their cash flow in the “As-a-Service” model. The last section shall explain the limitations of this thesis to invite further research in the future.

5.1 Underlying trends behind servitization

The findings reveal the influence of the Fourth Industrial Revolution (Industry 4.0) on the lighting industry. Companies have adopted advanced technologies not only in production lines, but also in service offerings such as software applications and new business models such as “data as a service”. Benitez et al. (2020) considers the Industry 4.0 as “a new industrial maturity stage” driven by the Industrial Internet of Things (IIoT) and a number of digital technologies such as big data, cloud computing and artificial intelligence (AI). Studying the technological role in the PPS systems, Gaiardelli et al. (2021) agree with this idea by describing digital technologies as a fundamental factor in transforming companies into a service-based business.

It is also noted that the manufacturers are acutely aware of sustainability and circular economy trends which have required them to redesign their operations by policies and initiatives. For instance, the European Green Deal policy adopted by the European Commission, with the goal of making Europe carbon-neutral in 2050, has committed players in all sectors to reduce the CO2 emissions, use resources more efficiently and become more sustainable (COM/2019/640). Figure 3 shows key components of the Green Deal.

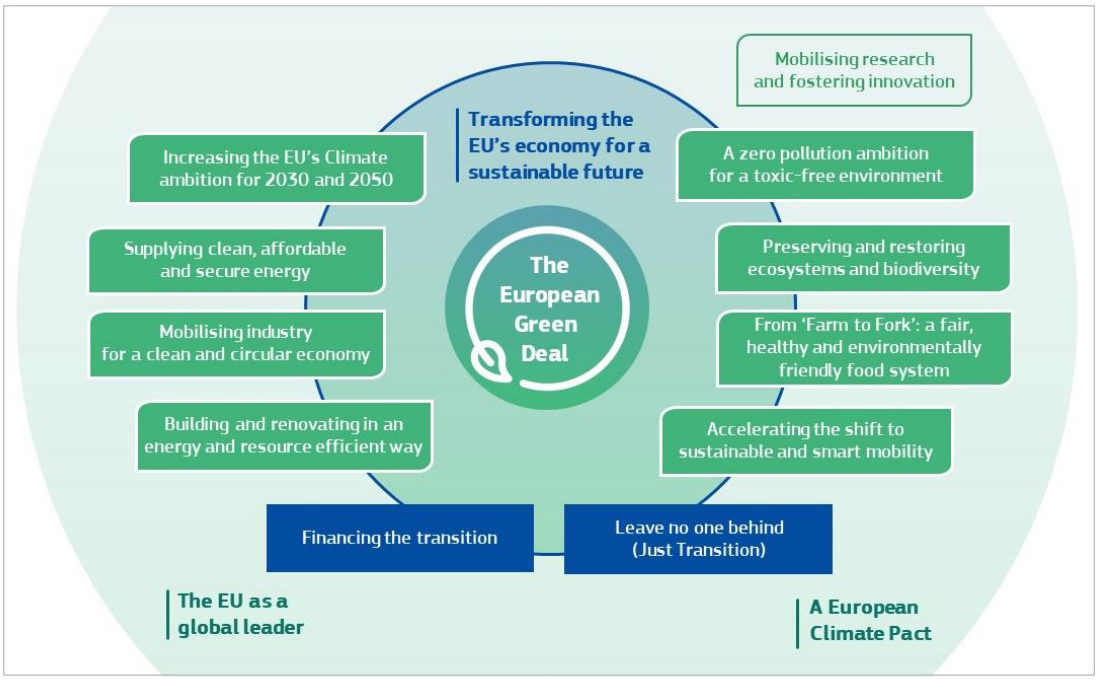

FIGURE 3. The European Green Deal (COM/2019/640)

According to Figure 3, the European Green Deal embodies different elements to transform the EU's economy for a sustainable future. It is evident that energy and resource efficiency as well as the transition towards a circular economy play a critical role in the European Green Deal. To follow this strategy, a great number of companies in the energy, construction, and renovation industries have tested innovative service ideas such as lighting audit.

In addition to the Green Deal, the EU has taken a variety of initiatives and policies to promote resource efficiency in recent years. Table 3 is a summary of EU policy frameworks that either directly or indirectly foster servitization, collected by Plepys et al. (2015). It is worth noting that there is currently no explicit policy for servitization and "As-a-Service" models. The most relevant protocols such as the Energy Services Directive (2006/32/EC) and the Energy Efficiency Directive (2012/27/EU) support resource effective practices and innovations. Futhermore, the extended product responsibility (EPR) programs with take-back schemes or deposit-return systems have indirectly created incentives for manufacturers across industries to collect used products and recycle the components.

TABLE 3. EU policy initiatives and instruments regarding resource efficiency (Plepys, et al., 2015)

Policy Initiatives/ Instruments	Examples
Direct to servitization	The Energy Services Directive (2006/32/EC) The Energy Efficiency Directive (2012/27/EU)
Indirect to servitization	The Packaging Directive The Directive on Waste Electric and Electronic Equipment (WEEE) The Extended Product Responsibility (EPR) programs

5.2 Value creation in servitization

The findings indicate that all lighting technology companies have offered a wide range of services, driven by different motives such as meeting customer's diverse demands, creating added values, maintaining competitiveness, engaging new customer groups and increasing market shares. The level of service complexity and customization relies on the case of buyer's needs and company's resources. However, a noteworthy point is that most of the manufacturers are still product-oriented as services are offered to add more values to the purchase and continue a relationship with the customer, not purposely earning significant profits. These results reinforce a collection of earlier research work.

In an interview about service-led business models, Baines (2014) asserts that servitization gives manufacturers considerable advantage because the products can be innovated easily and remain available for use during the service contract. Should product failure occur, the manufacturer will be able to process the defects and make necessary changes to ensure that future products will be better compatible with the application. In this case, manufacturers can recoup revenue by improving the delivery of the contracted services apart from product sales. Baines (2014) also adds that a manufacturer may initiate the transition to servitization to improve its competitive position and build long-term customer relationships. Another reason for servitizing is to get involved in the customer's operations, which

helps the manufacturer find needs for a product or service. This is also an opportunity to create unique values to the customer by proactively discovering new problems and solutions. (Baines, 2014)

Carrying out a case study into servitization of a tire manufacturing firm, Hyun and Kim (2021) highlight that the servitization model can bring a new revenue stream and new demands in the market. However, they also state that servitization might result in a higher revenue over time but does not necessarily increase profitability due to additional costs. According to their research findings, while marketing and labor costs might be lower with servitization than with traditional distribution channels, the high operating costs can lead to stagnation or service management problems. As another finding, the transformation process from a product-oriented manufacturing company to a servitized business is costly. In this case, the firm needs to carry out major organizational alterations to the procedure, culture, and leadership during servitization. (Hyun & Kim, 2021)

Furthermore, servitization is believed to bring changes to an organization and even the business model. Baden-Fuller and Morgan (2010) state that business models should be used to categorize for-profit organizations with similar attributes. They also mean that a firm should shape its business model to match the organizational strategy and operational activities. Their research analyzes three primary classification of business models by value creation, value delivery and value capturing, as illustrated in Table 4. Their comparison helps to better position servitization as a business model.

TABLE 4. Business model categorizations by value creation, value delivery, and value capturing (Baden-Fuller & Morgan, 2010)

	Product-oriented	Use-oriented	Result-oriented
Value creation	Seller oversees delivering the service(s) in contract.	Seller oversees the usability of the product or service.	Seller oversees delivering the service outcomes.
Value delivery	Product sales and contracted service(s) (e.g., maintenance or recycling).	Availability for usage of the product with service(s).	Service outcomes/ results.
Value capturing	Buyer pays for the product and provided service(s).	Buyer makes regular payments over a period (e.g., leasing).	Buyer pays for outcome/ result units.

According to the business model categorizations developed by Baden-Fuller and Morgan (2010) in Table 4, servitization falls into the use-oriented company group. Regarding value creation, while product- and result-oriented models focus on the services under contract, servitization generates values by the availability of the product with installation, maintenance, and upgrade services. Unlike product- and result-centric models in which a firm delivers the values through services upon merchandise sales, use-oriented companies bear the responsibility to ensure that the physical product is available for consumption with additional services. From the value capturing perspective, customers are liable to different payment forms: They pay for the goods and services by purchase in product- and result-oriented business models, while payment in servitization follows the subscription-based revenue model as a fee will be collected periodically during the contract term.

On the other hand, servitization of modular lighting solutions may have some risks such as channel conflicts and sales cannibalization because all firms in the value chain are generally dependent on each other. These findings are supported by an article by The Manufacturer (2015). They advocate that servitization could give access to a market in which problems have been solved with several alternatives by different suppliers, and hence there is a fierce competition. They also argue

that servitization requires a manufacturer to provide trainings and purchase new technologies to implement the new operational model. In terms of financial risks, servitization results in cash flow being spread over a longer period of time, which affects the revenue stream and financial performance. In the meantime, the firm will bear costs for maintenance and upgrade services to make sure the availability and usability of the product under contract. (The Manufacturer, 2015)

5.3 Calculation toolkit for manufacturers

The results reveal that manufacturers question the impacts of servitization on sales growth, revenues, costs, profitability and investment metrics such as break-event point and payback period. In addition to the qualitative study, this thesis will develop a calculation toolkit that allows a manufacturer to determine their cash flow in the ARA "As-a-Service" business model. The toolkit is based on ratio analysis in balance sheet analysis and illustrates core financial factors such as sales revenues, costs, profits and gross margins. The calculation model comprises 2 parts: Input table (Table 5) and Result table (Table 6).

TABLE 5. Calculation toolkit: Input table

*	Product standard cost (COGS) per unit	50
*	Profit margin (%)	50%
*	Volume (unit)	100
	Warranty period (year)	2
	Renting contract period (year)	3
	Annual failure rate (%)	0.30%

As seen in Table 5, the servitization financial toolkit requires the following factors of a specific product:

- Product standard cost (COGS) per unit: Total production costs for a unit.
- Profit margin: What is the portion of profits over sales for a unit of product?
- Volume: How many units are considered?

To demonstrate the calculation model for a typical luminaire, the required inputs will be set as follows:

- Product standard cost (COGS) per unit: 50
- Profit margin: 50%
- Volume: 100

In addition, other important factors needed for the calculations include warranty period, service contract term and product's annual failure rate. In this example model (Table 5), these factors will be set as follows:

- Warranty period: 2 (years)
- Renting contract period: 3 (years)
- Annual failure rate: 0.3%

TABLE 6. Calculation toolkit: Result table

(All the values are referenced from the industry standards)

Renting period (Years)	**3**	**5**	**7**	**10**	one-off sales
Volume (unit)	100	100	100	100	100
Product selling price (ex mauf. per unit)	100	100	100	100	100
Total product sales revenues	10,000	10,000	10,000	10,000	10,000
Product standard cost (COGS) per unit	50	50	50	50	50
Total product standard cost (COGS)	5,000	5,000	5,000	5,000	5,000
Failure Rate (per year)	0.3%	0.3%	0.3%	0.3%	0%
Repair cost per unit (Warranty)	60	60	60	60	60
Replacement cost per unit	0.99	1.65	2.31	3.3	0.66
Total replacement costs	99	165	231	330	66.00
Inflation rate per year	2%	2%	2%	2%	-
Nominal interest rate per year	4%	5%	6%	7%	-
Nominal interest per unit	4	5	6	7	-
Total Interest per year	400	500	600	700	-
Total interest revenues	1,200	2,500	4,200	7,000	-
Total costs	5,000	5,000	5,000	5,000	5,066
Total revenues	11,299	12,665	14,431	17,330	10,000
Annual revenues	3,766	2,533	2,062	1,733	-
(NPV) total revenue	10,862	11,600	12,374	13,382	-
Gross profit margin %	56%	61%	65%	71%	50%
Gross profits	6,299	7,665	9,431	12,330	4,934
(NPV) Gross profits	5,862	6,600	7,374	8,382	-
Gross margin increase	28%	55%	91%	150%	-
(NPV) Gross margin increase	19%	34%	49%	70%	-
Payback period (Year)	1.33	1.97	2.43	2.89	-
ROI	125.98%	153.30%	188.62%	246.60%	97.39%
Annualized ROI	31.23%	20.43%	16.35%	13.24%	

The calculation toolkit in Table 6 illustrates a primitive cash flow analysis of the "As-a-Service" business model compared to the one-off sales channel. According to this calculation model, manufacturers should consider several key factors:

Warranty and ownership costs

By law, a manufacturer in the EU is required to provide a warranty of at least 2 years (Directive 1999/44/EC). During the warranty period, the company must bear the costs of fixing and replacing the product if there is any broken one. Unlike the traditional one-off sales distribution, the product's ownership remains under the rights of the manufacturer in servitization (Tauqeer & Bang, 2018). Therefore,

maintenance, upgrade and replacement costs should be viewed in another way. The manufacturer can combine maintenance costs with the service fee or charge them as an extra fee which is lower than buying a new product. In this aspect, the “As-a-Service” model may lead to an increase in total revenues (Table 6), provided that the product durability level and failure rate are best determined.

Time value of money – Inflation

Time value of money is a principal concept in corporate finance which observes the value differences of two cash flows at two different points of time (Berk et al., 2017). Fernando (2021) considers this concept as a core principle of finance and project evaluation. He summarizes its meaning, which is that a sum of cash has greater value than the sum to be received at a future time because of its earnings potential in the interim.

As shown in Table 6, the calculation model takes into account the time value of money for revenues and gross profits with the Net Present Value method. It is a fact that servitization is a subscription-based revenue stream model by nature: The cash flow will be spread over a period of time. Therefore, a manufacturer’s cash flow, especially in revenues and gross profits will be discounted by inflation rates during the service contract term. It is evident that standard product costs are not affected by inflation because they occur in the first phase of service contract when the product is set up for usage by the manufacturer.

Cost benefit analysis

The calculation model also feeds a cost-benefit analysis for a manufacturer to determine the servitization process. Cost-benefit analysis is the decision-making process of quantifying the benefits and costs of an investment or a project (Berk et al., 2017). Hayes (2021) defines this technique as a systematic process to analyze the potential rewards and total costs of a course of actions or decisions.

Table 6 suggests that while companies mainly benefit from product sales in the traditional distribution channel, the benefits of servitization additionally include a service fee for maintaining and upgrading the product to ensure its availability for consumption during the contractual period. The financial value added of service-based contracts can be observed through a growth in total revenues and gross

profits despite inflation. This is consistent with previous research findings of Hyun & Kim (2021), mentioned in section 5.2. However, a manufacturer should also take into consideration break-even points and payback periods in their decision making to find an optimal solution.

It is noteworthy that if common success metrics of production such as number of units produced and worker employed or sales growth are used, the performance of servitization might look poor (Baines, 2014). He considers that the number of products to be manufactured, referred to as "dematerialization," may decline as servitization model provides more efficient products with a lower failure rate. Therefore, revenues, costs and profits should be considered differently in the “As-a-Service” business model, in relation to non-monetary values such as extended product lifecycle, sustainability and environmental friendliness. (Baines, 2014)

5.4 Research limitations

From the research methodological perspective, this thesis lacks general validity for industry-level conclusions for several reasons. First, this paper is a case study for a start-up with limited resources. Even though the research is fruitful to provide an in-depth case study within the time constraint, a small sample size may affect the reliability of the findings which can be biased.

Online interviews might be the second drawback. This kind of computer-based data collection method lacked the face-to-face interactions that could help to contextualize the interview participants. The interviewees might not be able to express their true opinions and non-verbal communications. In addition, half of the interviews were conducted in German language and translated into English language for further data analysis. This can be another constraint of this study as translation might have failed to convey meaningful messages that the interviewees wanted to deliver.

Moreover, it should be acknowledged that the calculation model with referenced data might have insufficient validity with respect to the spectrum of servitization.

Nevertheless, the proposed toolkit might provide a good illustration of a manufacturer's revenue stream and cash flow in service contracts, compared to the traditional distribution channels. It is worth noting that basic knowledge in finance and economics is needed to use the calculation toolkit effectively.

6 CONCLUSION

Servitization is a novel concept but one that is gaining traction in many industries. Understanding the servitization process and “As-a-Service” business model shall help technology manufacturers to assess the opportunities and challenges of partnering with ARA for modular lighting solutions.

ARA is a start-up company with its mission to make buildings more sustainable through lighting technologies. The primary objective of this thesis is to investigate the pros and cons of servitization in the lighting industry. As the second objective, this thesis develops a calculation toolkit from a manufacturing firm’s perspective. The calculation model was not only based on financial analysis and project evaluation methods, but also derived from industry standards and customized for the ARA team. The calculation model has been proved useful in providing initial evaluations about the “As-a-Service” model. Yet, it should be noted that despite the theoretical foundation, basic competence in financial statements and economics of a business is required to apply the toolkit successfully.

In this research, a bottom-up approach was taken for the servitization process with a conceptual design proposed by Farsi and Erkoyuncu (2020). The scientific theories and frameworks ensured that the study successfully examined ARA’s business model and cash flow of manufacturing partners comprehensively during contractual periods. The qualitative research methods were desirable for an exploratory study and practically helped to gain insights for the development of a financial analysis toolkit.

The findings suggest that servitization has a lot of potential in manufacturing as a tool to create new values, meet increasingly diverse needs of the end users and keep lasting customer relationships. Servitization allows manufacturers to efficiently innovate their product by being involved in the customer’s operations and detecting new problems. Advanced services also enhance a manufacturer’s position and maintain competitive edges by creating a disruptive business model – “As-a-Service”. Modular solutions especially have potential because there is a growing awareness of sustainability and circular economy worldwide. However, since servitization is still in infancy, more efforts on defining a service framework

are needed. It is of great importance that manufacturers examine their financial performance by weighing the total costs and benefits of servitization as well as non-financial values such as an entry to the circular economy.

For further research, it is recommended to take the concept of servitization from different perspectives and industries because this thesis is a start-up case study and hence lacks validity for industry-level generalizations. Nevertheless, years of experiences of the co-founders and interviews with large lighting companies have provided an in-depth case analysis of the servitization concept in manufacturing and a firm’s financial performance.

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APPENDICES

Appendix 1. Circular economy

According to the Ellen MacArthur Foundation (2015, 5), a circular economy is defined as a restorative and regenerative framework of production and consumption by design. It aims to utilize the resources at the utmost and capture the value creation in a loop of technical and biological cycles. It can be viewed as a continuous positive development cycle that maintains economic values of natural resources, maximizes material yields, and minimizes wastage by controlling certain stocks and renewable flows. The model of circular economy produces the same level of effectiveness at every economic scale.

In a fully circular economy, industrial processes and products are rigorously redesigned to keep resources in a perpetual circulation and reduce the amount of inescapable waste by recycling or recovering the residues to a maximum (European Investment Bank, 2020, 4). Hieminga (2015, 10) believes that the concept of circular economy is inspired by nature and its living systems. Kraanen (2016, 24-25) points out that one of the fundamentals is ‘waste is food’ which refers to the belief that all product components can re-enter production processes or become nutrients for the metabolisms after use.

In a publication, the Ellen MacArthur Foundation (2015) characterize the concept of circular economy with a system diagram (Figure 1) known as “The Butterfly Diagram”. Holistically, the diagram illustrates that the continuous flow of products, components and materials in a circular economy can be differentiated through two cycles:

- The technical cycle is related to the control of stocks of finite materials, flexible consumption models and technical materials being restored in a technical loop.
- The biological cycle involves the management of flows of renewable resources. Products are consumed and renewable (biological) nutrients are regenerated in the biological cycle.

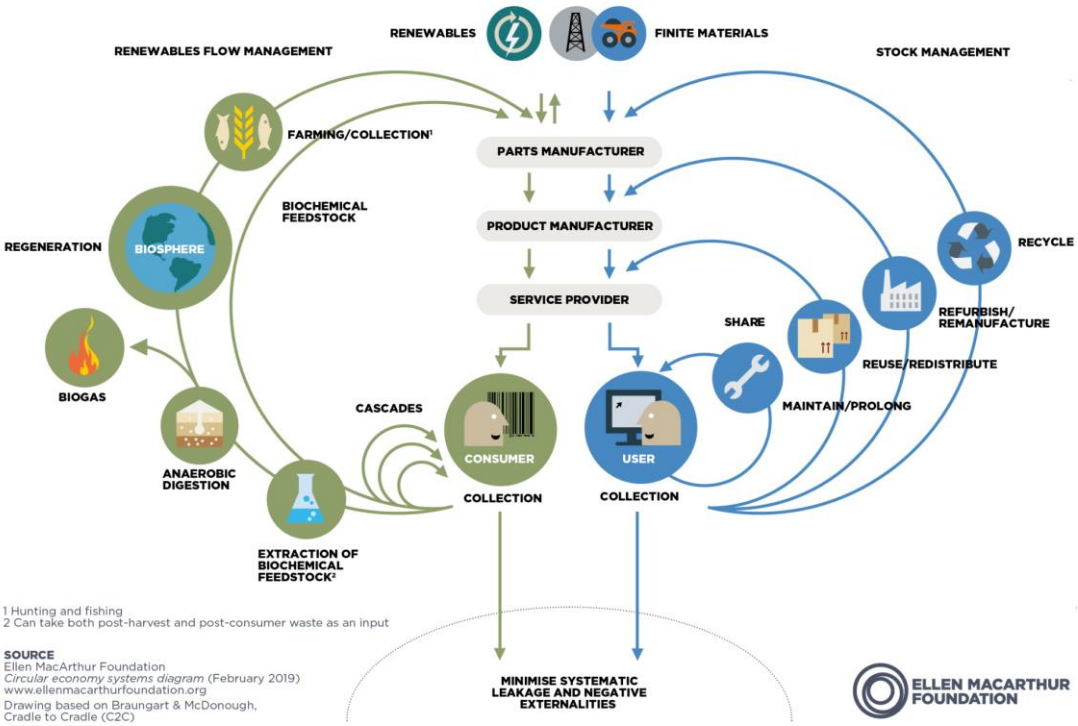

FIGURE 1. The Economy System Diagram (Ellen MacArthur Foundation, 2015)