Tampere University

MIKKO UUSKOSKI

Novel Opportunities for Outcome-Based Contract Business Models in Machine Manufacturing Industry

Tampere University Dissertations 1421

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ACADEMIC DISSERTATION
To be presented, with the permission of
the Faculty of Management and Business
of Tampere University,
for public discussion in the auditorium TB109
of the Tietotalo, Korkeakoulunkatu 1, Tampere,
on January 23rd 2026, at 12 o'clock.

ACADEMIC DISSERTATION
Tampere University, Faculty of Management and Business
Finland

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The originality of this thesis has been checked using the Turnitin Originality service.

Cover design: Roihu Inc.

ISBN 978-952-03-4371-2 (print)
ISBN 978-952-03-4372-9 (pdf)
ISSN 2489-9860 (print)
ISSN 2490-0028 (pdf)
http://urn.fi/URN:ISBN:978-952-03-4372-9

PunaMusta Oy – Yliopistopaino
Joensuu 2026

PREFACE

The initial motivation for this dissertation was to bridge research and industrial practice to create value for both academia and industry. The study examines the design, benefits, risks, and implementation challenges of Outcome-Based Contract (OBC) business models in the machine manufacturing sector, with a particular emphasis on small and medium-sized enterprises (SMEs).

The motivation for this work originates from my long-standing professional background in the automation and machinery industry. Throughout my career, I have observed a growing interest in service-based and performance-oriented offerings. At the same time, I have witnessed the practical challenges that many firms, especially SMEs, face in designing and implementing such models. This persistent tension between strategic aspiration and operational reality inspired the central research questions of this dissertation.

During the research process, I had the privilege of engaging with numerous industry professionals, company representatives, and academic colleagues. Their openness, insights, and critical feedback have been invaluable in shaping both the direction and the depth of this work. I am particularly grateful to the case companies that participated in the empirical studies for their time, trust, and willingness to share their experiences. Without their contribution, the practical grounding of this research would not have been possible.

I wish to express my deepest gratitude to Professor Hannu Kärkkäinen, whose mentorship, expertise, and continuous encouragement have been central to the completion of this dissertation. His academic guidance, wise advice, and ability to bring clarity in moments of uncertainty have been invaluable. Beyond this work, our collaboration on several academic projects has greatly enriched my understanding of research and strengthened my commitment to academic inquiry. Professor Kärkkäinen's example has taught me the meaning of genuine academic integrity, and his influence will continue to guide my future endeavors.

My sincere thanks also go to Dr. Karan Menon, who has been a second central collaborator and supporter throughout the writing of the research papers. His analytical precision, calmness, and readiness to assist during challenging moments have been essential in bringing this work to completion.

I also thank Professor Kari Koskinen, who contributed as a co-author to my first publication. His expertise, constructive comments, and guidance during the development of that work provided an important foundation for the research that followed and supported the overall progression of this dissertation.

I would also like to thank the entire research team led by Professor Kärkkäinen over these seven years. Working in such a positive and collaborative environment has been a privilege. I am especially grateful to Dr. Sameer Mittal and Dr. Olli Kuismanen, whose collegiality, insights, and encouragement have contributed significantly to this journey. The Unit of Information and Knowledge Management has provided excellent resources, academic freedom, and an inspiring research environment, all of which have been instrumental in completing this dissertation.

I am honored to have had two distinguished scholars as the pre-examiners of this dissertation: Professor Dr. Petri Ahokangas (University of Oulu) and Professor Dr. David Romero (Tecnológico de Monterrey). I wish to thank them sincerely for the time and expertise they dedicated to evaluating this work and for the valuable feedback that strengthened the final version. As this is an article-based dissertation, I am also grateful to my co-authors, reviewers, journal editors, and conference organizers who supported the publication of the included papers.

Above all, I wish to express my heartfelt gratitude to my wife, Tiina, whose unwavering support made this entire journey possible. She has been my closest partner throughout the process, balancing her own demanding career while managing our family life with patience, care, and strength. Her belief in me, even during moments of self-doubt, and her constant encouragement have been one of the foundations of my resilience.

I also extend my warmest thanks to my sons, Ville and Olli, for their understanding and support. They have taken on daily responsibilities, given me the time and space to focus on my research, and reminded me of what truly matters beyond academic work. Their patience, humor, and presence have been a constant source of motivation and joy.

Finally, I hope this dissertation will provide value to both researchers and practitioners. For academics, it offers a framework to better understand the contextual and organizational dynamics that shape OBC adoption. For industry stakeholders, particularly in SMEs, it presents tools, concepts, and insights to support more informed decision-making in the design and scaling of outcome-based business models. If even one company benefits from these findings, or one researcher builds upon them in future studies, I will consider the effort worthwhile.

This preface was written on a beautiful winter morning in Tuulensuu, Mäntyharju, on the 30st of December 2025.

Mikko Uuskoski

ABSTRACT

This dissertation explores how Outcome-Based Contracting (OBC) Business Models (BMs) can be effectively adopted and designed by machine manufacturers (MMs), with a special focus on small and medium-sized enterprises (SMEs). OBC BMs shift the focus from selling equipment to delivering measurable outcomes, such as machine uptime, output volume, or cost savings. While these models offer benefits like enhanced customer relationships, sustainability, and recurring revenue streams, they also pose notable implementation challenges, particularly for resource-constrained SMEs lacking prior experience in service-based value delivery or performance-driven contracts.

A significant research gap exists, as the current OBC literature predominantly focuses on large enterprises, offering limited insight into the specific needs, constraints, and capabilities of SMEs operating in capital-intensive industries. These firms often operate with lower margins, leaner organizational structures, and limited digital infrastructure. To address this, the dissertation develops a robust conceptual framework and adaptable design model for OBC BM adoption. The dissertation adopts an interpretivist philosophy and a qualitative, inductive methodology based on Saunders' Research Onion. Using a multiple-case study design, it explores how outcome-based and pay-per-use business models are developed in industrial SMEs and large companies. Data were collected through semi-structured interviews and analyzed thematically to generate contextual insights linking empirical findings with existing theory on business model innovation and servitization.. Data were gathered through three peer-reviewed and one submitted studies combining interviews, case studies, and literature reviews with expert validation to ensure a well-rounded analysis of real-world practices.

The dissertation addresses two core research questions: (1) What are the opportunities and risks of OBC BMs for MMs? and (2) How can MMs, particularly SMEs, design and implement these BMs effectively? The findings reveal that SMEs and large firms approach OBC adoption differently: SMEs tend to value agility, customized offerings, and stronger customer intimacy, while large firms emphasize scalability, digital integration, and process standardization. These differences influence how contracts are structured, risks are managed, and customer expectations are addressed. The dissertation identifies 16 critical decision criteria—such as asset ownership during and after contracts, payment and pricing models, maintenance and operational responsibilities—and applies morphological analysis to propose BM design configurations suited to different strategic contexts.

Key contributions of this dissertation include expanding the scope of OBC BM research to include SME manufacturing companies; introducing a grounded and customizable configuration framework that reflects real-world business needs; and providing practical tools, such as decision matrices and risk mitigation strategies, to support implementation. The work highlights how outcome-based approaches can be strategically aligned with Industry 4.0 capabilities, including IoT, predictive maintenance, and data analytics—to create differentiated value propositions.

This dissertation supports the broader transition toward digital servitization, strategic innovation, and sustainable business practices within the manufacturing sector. By offering a contextualized, empirically validated pathway for navigating the shift from product-centric to outcome-oriented business models, this dissertation delivers value to academics, policymakers, and industrial practitioners. It also contributes to the ongoing development of business model innovation theory by integrating size-specific insights and operational realities of manufacturers in dynamic, digitally transforming markets.

TIIVISTELMÄ

Tämä väitöskirja tutkii, miten tulosperusteiset sopimus- (Outcome-Based Contracting, OBC) liiketoimintamallit (Business Models, BMs) voidaan tehokkaasti omaksua ja suunnitella konevalmistajien (Machine Manufacturers, MMs) toiminnassa, erityisesti pienten ja keskisuurten yritysten (PK-yritysten) näkökulmasta. OBC-liiketoimintamallit siirtävät painopisteen laitteiden myynnistä mitattavien tulosten tuottamiseen, kuten koneiden käyttöasteeseen, tuotantomäärään tai kustannussäästöihin. Vaikka mallit tarjoavat etuja, kuten asiakassuhteiden vahvistumista, kestävyyttä ja toistuvia tulovirtoja, ne aiheuttavat myös merkittäviä käyttöönottohaasteita – erityisesti resurssirajoitteisille PK-yrityksille, joilla ei ole aiempaa kokemusta palvelupohjaisesta arvonluonnista tai suorituskykyyn sidotuista sopimuksista.

Merkittävä tutkimusaukko on olemassa, sillä nykyinen OBC-kirjallisuus keskittyy pääasiassa suuriin yrityksiin ja tarjoaa vain rajallisesti näkökulmia pk-yritysten erityisiin tarpeisiin, rajoitteisiin ja kyvykkyyksiin pääomavaltaisilla toimialoilla. Nämä yritykset toimivat usein pienemmillä katteilla, kevyemmillä organisaatiorakenteilla ja rajallisella digitaalisella infrastruktuurilla. Tätä aukkoa paikkaamaan väitöskirjassa rakennetaan käsitteellinen viitekehys ja mukautuva suunnittelumalli OBC-liiketoimintamallien käyttöönottoon. Monitapaustutkimuksen avulla tarkastellaan, miten tulosperusteisia ja käyttöperusteisia liiketoimintamalleja kehitetään teollisuuden pk- ja suuryrityksissä. Aineisto kerättiin puolistrukturoiduin haastatteluin ja analysoitiin temaattisesti tuottaen kontekstuaalisia päätelmiä, jotka yhdistävät empiiriset havainnot olemassa olevaan liiketoimintamalli-innovaation ja palvelullistumisen teoriaan. Tutkimusaineisto koostuu kolmesta vertaisarvioidusta ja yhdestä arviointiin jätetystä artikkelista, jotka yhdistävät haastatteluja, tapaustutkimuksia ja kirjallisuuskatsauksia asiantuntijavalidoinnin kanssa, varmistaen kokonaisvaltaisen analyysin käytännön ilmiöistä.

Väitöskirja vastaa kahteen keskeiseen tutkimuskysymykseen: (1) Mitkä ovat OBC-liiketoimintamallien mahdollisuudet ja riskit konevalmistajille? ja (2) Miten konevalmistajat – erityisesti PK-yritykset – voivat suunnitella ja toteuttaa nämä mallit tehokkaasti? Tulokset osoittavat, että PK-yritykset ja suuret yritykset lähestyvät OBC:n käyttöönottoa eri tavoin: PK-yritykset arvostavat ketteryyttä, räätälöityjä ratkaisuja ja tiiviimpiä asiakassuhteita, kun taas suuret yritykset painottavat skaalautuvuutta, digitaalista integraatiota ja prosessien standardointia. Nämä erot vaikuttavat siihen, miten sopimukset rakennetaan, riskejä hallitaan ja asiakasodotuksiin vastataan. Väitöskirja tunnistaa 16 kriittistä päätöksentekokriteeriä – kuten omaisuuden omistajuus sopimuskauden aikana ja sen jälkeen, maksu- ja hinnoittelumallit, huolto- ja operointivastuut – ja soveltaa morfologista analyysiä esittääkseen eri strategisiin konteksteihin sopivia suunnittelukonfiguraatioita.

Väitöskirjan keskeisiä tieteellisiä kontribuutioita ovat: OBC-liiketoimintamallien tutkimuksen laajentaminen koskemaan myös valmistavan teollisuuden PK-yrityksiä; käytännön liiketoimintatarpeet huomioivan, perustellun ja muokattavan konfiguraatiokehyksen esittely; sekä konkreettisten työkalujen, kuten päätösmatriisien ja riskienhallintastrategioiden, tarjoaminen käyttöönoton tueksi. Työssä korostetaan, kuinka tulosperusteisia lähestymistapoja voidaan strategisesti yhdistää teollisuus 4.0 -kyvykkyyksiin – mukaan lukien IoT, ennakoiva huolto ja data-analytiikka – erilaistettujen arvolupausten luomiseksi.

Tämä väitöskirja tukee laajempaa siirtymää kohti digitaalista palveluliiketoimintaa, strategista innovaatiota ja kestävää liiketoimintaa valmistavassa teollisuudessa. Tarjoamalla kontekstualisoidun ja empiirisesti varmennetun polun siirtymiseen tuotekeskeisistä kohti tulosorientoituneita liiketoimintamalleja, väitöskirja tuottaa arvoa niin tutkijoille, päättäjille kuin teollisuuden käytännön toimijoille. Lisäksi työ edistää

liiketoimintamallien innovaatioteorian kehitystä tuomalla siihen yrityskoon mukaan huomioivia näkökulmia ja valmistavan teollisuuden operatiivisia realiteetteja dynaamisissa, digitaalisesti muuttuvissa markkinoissa.

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Publication II Mikko Uuskoski, Hannu Kärkkäinen, Karan Menon. Rapid Sales Growth Mechanisms and Profitability for Investment Product Manufacturing SMEs Through Pay-Per-X Business Models. 17th IFIP International Conference on Product Lifecycle Management (PLM), Jul 2020, Rapperswil, Switzerland. pp.402-415, 10.1007/978-3-030-62807-9_32. hal-03753096

Publication III Karan Menon, Sameer Mittal, Muztoba Ahmad Khan, Hannu Kärkkäinen, Thorsten Wuest, Mikko Uuskoski. Morphological Analysis for Designing and Configuring Outcome-based Contracts for Machine Manufacturers: An Empirically Grounded Conceptualization. Submitted to Journal of Enterprise Information Management.

Publication IV Uuskoski, M., Mittal, S., Menon, K., Kärkkäinen, H., 2023. Challenges, Mitigation and Benefits of Outcome-based Contracts in Small and Medium-sized Machine Manufacturers: A Qualitative Exploratory Study. International Journal of Mathematical, Engineering and Management Sciences. 8, 1149–1170. https://doi.org/10.33889/IJMEMS.2023.8.6.065

AUTHOR´S CONTRIBUTION TO CO-AUTHORED PUBLICATIONS

In Publication I, I served as the principal author. My contributions included leading the manuscript's composition, conducting interviews, and drafting the results and discussion sections. In collaboration with my co-authors, we addressed the reviewers' feedback and implemented the requisite modifications. Additionally, I had the opportunity to present this work at the Product Lifecycle Management 2019 conference.

In Publication II, my role was that of the lead author. The conceptual framework of the study was co-developed with my colleagues. I was responsible for designing the case study methodology, composing the introduction, and define the research approach. The discussion section was enhanced with input from my co-authors. Together, we engaged with peer review comments, making the necessary amendments. I presented this paper at the Product Lifecycle Management Conference in 2020.

Publication III was led by Karan Menon, with whom I had the privilege of serving as a co-author. My involvement extended to various facets of the paper's development, including the conduct of interviews. Additionally, I undertook the coding of the interviews. My contributions also encompassed the content of the final framework, which stands as one of the paper's significant outcomes.

In Publication IV, I assumed the position of principal author. My contributions were pivotal in the acquisition and coding of data. Furthermore, I was responsible for composing the results and discussion sections. As the lead author, my engagement in the comprehensive writing process of the paper was substantial.

1 INTRODUCTION

1.1 Background

The adoption of outcome-based contracting (OBC) business models (BMs) is gaining momentum within the manufacturing industry due to their adaptability, cost efficiency, and results-oriented logic, wherein customers pay solely for specific outcomes such as machine availability, production output, or financial savings (Korkeamäki, 2021; Grubic & Jennions, 2018). Recent studies further emphasize that the relevance of OBC BMs has increased as manufacturers seek to enhance value creation and long-term customer relationships through data-driven services and digital performance monitoring (Uski et al., 2022; Korkeamäki et al., 2022).

OBC BMs have redefined traditional manufacturing operations by shifting the focus from one-time product sales to comprehensive, performance-based solutions. This transformation enables manufacturers to integrate digital technologies and predictive maintenance capabilities to ensure contractual outcomes, thereby aligning economic and operational incentives between provider and customer (Uski et al., 2025). The transition not only strengthens competitiveness and customer loyalty but also enhances managerial and analytical capabilities (Baines et al., 2007) and supports broader sustainability objectives through resource efficiency and lifecycle optimization (Tukker, 2015).

For small and medium enterprises (SMEs) in particular, OBC BMs present a pathway to navigate competitive pressures and increase profitability by opening new revenue channels and tapping into niche markets. For large companies OBC BMs offers multiple new ways to monetize their product and services. Especially, OBC BMs allow SMEs to differentiate themselves from larger corporations, fostering growth and competitiveness amid challenging market conditions (Mittal et al., 2018). Additionally, these models have proven resilient during crises, such as the COVID-19 pandemic, by offering flexible revenue streams that can adapt to market fluctuations.

The broad application of OBC BMs also drives technological innovation by monetizing advancements like automation, the Internet of Things (IoT), and artificial intelligence (AI). Such integration not only supports revenue and profitability but also enables continuous cash flow, crucial for business stability. Advanced technology in machinery improves performance, reduces energy consumption, and decreases wear, contributing to sustainable practices and environmental conservation (Tukker, 2015; Sørensen, 2023).

The manufacturing industry is undergoing transformative change under Industry 4.0, characterized by IoT, data analytics, and cyber-physical systems, which require high levels of integration across production and service lines, as exemplified by Germany's Industry 4.0 initiative (Menon et al., 2019; Zancul et al., 2016). However, SMEs face distinct barriers in adopting these technologies and transitioning to OBCs, primarily due to financial limitations, risk aversion, and smaller operational scales (Müller et al., 2018; Rapaccini, 2015). Unlike larger companies, which can absorb longer payback periods and diversify revenue streams, SMEs require pragmatic strategies to mitigate the lifecycle and operational risks that OBCs entail (Grubic & Jennions, 2018).

While business model tools like the Business Model Canvas provide foundational support for transitioning to OBCs, they often lack the specificity needed to address SMEs' unique challenges (Barquet et al., 2013; de Oliveira et al., 2018). Existing frameworks also predate key Industry 4.0 developments, failing to account for issues like data ownership, real-time analytics, and the complexities of maintaining sophisticated equipment over extended lifecycles (Mittal et al., 2020; Rymaszewska et al., 2017). This research gap is particularly significant for B2B MMs, where machine ownership incurs substantial costs and logistical complexities (Rapaccini, 2015; Adrodegari et al., 2017).

Further research is needed to explore effective OBC BM adoption strategies tailored especially to the needs of SMEs, including best practices and adaptable frameworks that enable these companies to implement OBC BMs successfully and compete sustainably (Baines & Lightfoot, 2014; Uski et al., 2022). This gap is also relevant to larger enterprises, which require updated frameworks that integrate Industry 4.0 advancements to support comprehensive lifecycle management and sustainable strategies (Lay et al., 2009; Hypko et al., 2010; Korkeamäki et al., 2022). This dissertation develops a conceptual framework for the design and structuring of OBC-based BMs, offering practical guidance for their implementation within the manufacturing sector. In addition, the conceptual framework was further developed through expert interviews, which enabled the identification of additional parameters to enhance its comprehensiveness and applicability.

Addressing this dissertation research gap is crucial for fostering growth, promoting innovation, and advancing sustainability across the manufacturing sector. Such efforts will empower both SMEs and larger companies to transition effectively from traditional product sales to service-oriented models, aligning business expansion with environmental responsibility and global competitiveness (Tukker, 2015). For professionals in automation and related sectors, this shift presents opportunities for revenue growth and supports sustainability objectives by improving technological efficiency and conserving resources.

Overall SMEs provide a particularly relevant setting for studying the transition to digitally enabled, service-oriented business models. This dissertation places SMEs at the center of its investigation into digital servitization and outcome-based business. The findings reveal how SMEs leverage their adaptability, proximity to customers, and willingness to experiment to gradually implement outcome-oriented models, even while navigating resource limitations.

From an academic perspective, the dissertation contributes to the literature by demonstrating how SME-specific factors, such as size, organizational agility, and strategic informality, affect the design, implementation, and scaling of OBC BMs. It provides a more nuanced view of BMI by moving beyond the traditional focus on large companies with formalized innovation structures. From a managerial standpoint, the dissertation offers actionable tools, such as a morphological box, which is well-suited to the capabilities and decision-making styles of SMEs. These tools support gradual transformation and strategic learning, aligning with SMEs' practical needs.

This dissertation examines advanced OBC BMs, including pay-per-output, pay-per-outcome, and pay-per-use models. This dissertation contributes to the body of knowledge by advancing research streams in several key areas: the development of frameworks for designing OBC BMs, strategies for implementation and evaluation of these models, and an exploration of OBC BMs within the context of SMEs. Additionally, this dissertation

contributes to a deeper understanding of the mechanisms driving sales growth and profitability by enhancing the evaluation of risks and benefits associated with the implementation of OBC BMs.

Therefore, advancing research on OBC BMs specifically for SMEs is particularly significant and directly relevant to the aims of this dissertation. Such research supports SMEs in transitioning to value-based offerings, strengthening customer relationships, and enhancing competitiveness—especially when enabled by digital tools and modular, scalable implementation frameworks.

Overall, from SME size company point of view this dissertation provides novel insights into the implementation of outcome-based business models (OBC BMs) in small and medium-sized enterprises (SMEs), particularly those enabled by digital technologies. Additionally, it offers innovative approaches for SMEs to design and implement OBC BMs effectively. Furthermore, it introduces new mechanisms for achieving sales growth and profitability in manufacturing companies through the adoption of OBC BMs.

As an addition to the existing research this dissertation explores the benefits and risks associated with the implementation of OBC BMs in MMs (Publications I and II) and identifies critical Decision Criteria for OBC PM design in MMs. By building upon existing frameworks, this dissertation aims to provide a structured approach to support MMs in navigating the complexities of OBC implementation, mitigating associated risks, and optimizing lifecycle profitability.

1.2 Significance of the research topic

While OBC BMs have been extensively studied, prior research has primarily concentrated on large corporations instead of SMEs, and in addition, leaving the specific context of machine manufacturers (MMs) relatively underexplored. In this dissertation, we demonstrate how large companies and especially SME MMs can benefit from OBC BMs, what are significant benefits and risks, and how these risks can be mitigated. In addition, this dissertation develops a conceptual framework for designing and implementing OBC-based BMs in manufacturing. Through expert interviews, the framework was further refined by identifying additional key parameters to enhance its comprehensiveness and applicability.

Despite growing scholarly interest in OBC BMs, current literature remains heavily centered on large manufacturing firms, leaving limited understanding of how SMEs in machine manufacturing can adopt and benefit from such models. Research has largely overlooked the financial, organizational, and operational constraints that shape SME participation, including challenges related to upfront asset financing, cash-flow management, and performance-risk exposure. Existing studies also provide little insight into the practical implementation of OBC BMs, how SMEs build required capabilities, reconfigure sales and service structures, develop data-driven performance measurement systems, or manage organizational change. Furthermore, the critical role of ecosystems remains underexplored, particularly how SMEs collaborate with financiers, digital solution providers, maintenance partners, or customers to share risk and resources. Conceptually, OBC BMs are often treated as uniform, despite contextual variations in machine types, customer expectations, digital maturity, and market conditions, resulting in limited configurational and comparative theorization. Empirical evidence on customer readiness, long-term scalability, and actual performance outcomes in SME contexts is

also scarce. Collectively, these gaps indicate that the field still lacks a nuanced, context-sensitive understanding of how OBC BMs emerge, function, and evolve within resource-constrained machine-manufacturing environments, highlighting the need for deeper empirical, financial, and process-oriented research.

Manufacturing enterprises that were previously selling their machines have now started to offer outcome with the help of outcome-based contract business models (OBC BMs). In OBC BMs this outcome is in the form of the hours of machine availability, output units produced from the machine, and the savings/ economy created by the OBC BMs (Korkeamäki, 2021; Grubic and Jennions, 2018). Offering OBC BMs manufacturing enterprises have many advantages, such as becoming loyal suppliers (Baines *et al.*, 2007), and positive environmental impacts (Tukker, 2015; Sørensen, 2023). In this study, we want to understand what challenges and benefits SME MMs have while offering OBC BMs.

The emergence of Industry 4.0 and IIoT technologies has a significant impact on how products are being offered with the help of outcome-based contract business models (OBC BMs), especially by MMs (Menon et al., 2019). As a result, manufacturers that previously sold machines as investment-based product, have started to offer 'outcome' of the machine (Helander and Moller, 2007; 2008). The outcome can be based on the available hours (a-OBC), outcome units produced (o-OBC), and the economic savings and profits (e-OBC) created by the machines (Ziaee Bigdeli et al., 2018; Baines and Lightfoot, 2014; Uski et al., 2022). Thus, the focus is on becoming a solution provider (Ziaee Bigdeli et al., 2018; Baines and Lightfoot, 2014).

Owing to the risks and challenges involved in offering OBC BMs, MMs struggle to design and implement OBC BMs. Over the last decade, various types of OBC BMs have gained traction in MMs. However, scientific literature regarding design of OBC BMs for MMs is limited. There are also a limited number of OBC BM-related detailed case studies dispersed in various academic and non-academic studies. The findings derived from the examples and case studies from other industries are not applicable to MMs. Unlike many other industries, MMs operate in B2B, and their machines are expensive and sophisticated (Rapaccini, 2015). Thus, the risks of owning the machine and the significant efforts required to perform operational activities, such as logistics and installation, are very different (Hedvall et al., 2025; Adrodegari & Saccani, 2017).

MMs struggle to design and configure new outcome-based services (OBS) independently because there are many important decision points or characteristic features (CFs) that impact the lifecycle profits as well as risks when delivering the outcome offered by the machine (Kuismanen et al., 2024; Holgado & Macchi, 2023). Likewise, there are many options regarding these CFs, which need to be considered carefully, as these options can affect the profits and risks that MMs must face while structuring OBC BMs. In addition, many of these options have been developed and matured only recently; for example, financial instruments specifically designed for companies offering OBC BMs (Knecktys et al., 2022).

Much of the academic and practice-oriented literature related to the design of OBC BMs, uses rather generic business model (BM) design tools, such as the business model canvas (BMC) (Barquet et al., 2013; Adrodegari & Saccani, 2017; de Oliveira et al., 2018). These approaches are generic in the sense that they solely demonstrate which broad business model (BM) components should be considered when designing various types of BMs. They address specific decisions related to different types of BMs, and their design is independent of BM type and context. Furthermore, they do not bring forth more detailed BM decisions that companies need to address

or provide easy access to the different options that will help companies configure their BMs. Thus, the results and implications of such studies cannot lead to a more detailed design of specific types of BMs, such as OBC BMs, nor provide in-depth insights in a specific industrial context, such as MMs.

The Business Model Innovation (BMI) process from the Cambridge BMI framework (Brownlow et al., 2015), provides a structured approach to developing and implementing business model innovations. It consists of five key phases: initiation, ideation, concept design, integration, and implementation. The concept design phase serves as a critical bridge between creative ideation and practical realization, focusing on translating preliminary ideas into feasible business model concepts. During this phase, alternative configurations are explored and evaluated in terms of value creation logic, resource alignment, and risk–reward balance to ensure the viability of the proposed business model before full-scale integration and implementation.

In this dissertation, the primary focus is on the concept design phase of business model innovation, while also briefly addressing aspects of detailed design. The concept design phase involves the generation, exploration, and refinement of initial business model ideas, ensuring that they align with strategic objectives and market needs. This phase typically includes ideation, virtual prototyping, and experimentation, allowing for an iterative development process before progressing to full-scale implementation.

In addition of the conceptualization stage, this dissertation also touches detailed design elements, particularly in areas that require practical validation and feasibility assessment. The detailed design phase generally involves piloting, testing, and final adjustments before launching the business model. By integrating some aspects of detailed design, this dissertation aims to bridge the gap between conceptual development and practical application, ensuring that proposed models are not only theoretically sound but also applicable in real-world business environments.

Addressing the significance of the dissertation and research gap in Outcome-Based Contracting Business Models (OBC BMs) for SMEs and Large Enterprises

Existing research on outcome-based contracting business models (OBC BM) has predominantly focused on large manufacturing enterprises, often overlooking the distinct challenges faced by small and medium-sized enterprises (SMEs). SMEs encounter significant barriers to adopting Industry 4.0 technologies and OBC models, including limited financial resources, lower risk tolerance, and dependency on a narrow range of revenue sources. Despite the increasing relevance of servitization, there remains a lack of actionable frameworks tailored to SMEs. Current literature does not adequately address critical SME-specific challenges related to OBC implementation, such as managing costly equipment ownership, operational risks, and financial constraints. This gap leaves SME manufacturers without clear guidance on how to adopt and scale OBCs effectively within their business models.

For large enterprises, the limitations of outdated conceptual models present additional challenges. Many existing OBC frameworks predate the widespread integration of advanced Industry 4.0 capabilities, such as real-time data analytics, IoT, and predictive maintenance systems. As a result, they fail to address modern complexities related to data ownership, technological modernization, and sustainability. While large enterprises generally have more experience with OBC BM implementation, research has not sufficiently explored how

they navigate lifecycle challenges, particularly concerning long product lifecycles, maintenance responsibilities, and equipment upgrades.

Addressing these research gaps is essential for both SMEs and large enterprises. For SME MMs, this dissertation provides practical insights and risk mitigation strategies to support the confident adoption of outcome-based business models through the use of digital tools and innovative business model design By overcoming financial and operational barriers, SMEs can enhance profitability and drive sustainable growth. For large enterprises, modernizing OBC BM strategies is crucial to maximizing lifecycle profitability and reducing operational risks. The development of comprehensive frameworks that integrate digital capabilities and sustainability considerations is essential for maintaining long-term competitiveness in a rapidly evolving market.

Given the economic significance of SMEs, particularly within the EU and global markets, and the growing shift towards service-oriented business models in manufacturing, closing these research gaps can facilitate the widespread adoption of OBC BMs across the industry. Advancements in this area will contribute to technological innovation, economic resilience, and sustainable manufacturing practices (Tukker, 2015). A deeper understanding of OBC BM adoption will enable manufacturers to leverage Industry 4.0 technologies, ensuring scalable, practical solutions that promote sustainable business models and long-term industry leadership.

1.3 Research objectives and research questions and objectives of the dissertation

Addressing the previous research gaps

The primary objective of this dissertation is to provide a comprehensive analysis of how outcome-based contracting (OBC) business models (BMs) create new opportunities for machine manufacturers (MMs). Specifically, it investigates how these opportunities, both in terms of potential benefits and associated risks, were in SME and large company (Grubic & Jennions, 2018; Korkeamäki, 2021; Uuskoski et al., 2023). In addition, the dissertation develops a conceptual framework for the design and structuring of OBC-based business models, offering practical guidance for their implementation in the manufacturing sector (Ng & Nudurupati, 2010; Baines et al., 2020). The framework was further refined through expert interviews, which enabled the identification of additional parameters to improve its comprehensiveness, contextual relevance, and practical applicability (Kuismanen et al., 2024).

Following Illustration 1 presents a Venn diagram about the research gap concerning OBC BMs in the machine manufacturing sector. The dissertation also examines this gap from the perspectives of both SMEs and large companies, offering a comparative view of their respective approaches, challenges and opportunities.

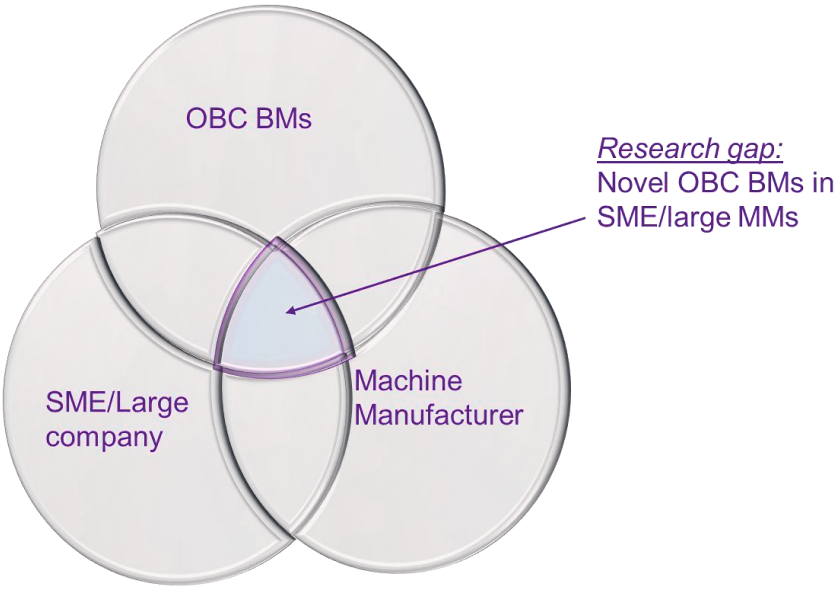


Figure 1. Venn diagram of the research gap.

Research questions

To address the identified research gap, this dissertation is structured around two core research questions. These questions guide the investigation into both the strategic implications and the practical design of OBC BMs models in the machine manufacturing sector. The following table summarizes how each publication contributes to answering these questions. Section 5.2 introduces the research questions guiding this dissertation.

Despite increasing interest in OBC BMs within manufacturing, there remains a limited understanding of their practical implementation and strategic impact, particularly in the MM sector. Existing literature has largely emphasized generic benefits and conceptual aspects of OBC BMs, while often neglecting how their adoption and impact differ across company sizes. SMEs, in particular, have received insufficient scholarly attention, despite their distinct resource constraints, capabilities, and strategic priorities compared to larger firms.

This dissertation addresses these shortcomings by asking how OBC BMs create both opportunities and risks for SMEs and large MMs, and by investigating how such models can be systematically designed and implemented in practice. The research questions thus extend beyond identifying theoretical benefits to examining mechanisms that influence sales growth, profitability, and strategic positioning in SMEs (Publications I and II), as well as exploring the organizational processes, challenges, and enablers of OBC BM adoption (Publications III and IV). In doing so, the dissertation not only investigates the consequences of OBC BMs but also refines and advances a conceptual framework that provides structured insights into their

design and application. There are only very few earlier studies that help to understand advanced OBC BM design and implementation in equipment manufacturing companies, especially in the context of SMEs.

Table 1. RQs and their Interconnections with publications.

Research Questions	**Main academic contributions of the publications towards the research questions**
RQ 1 - What kind of opportunities (benefits and risks) do OBC BM offer for MMs (SMEs and large companies)?	Publication I extends this knowledge by focusing specifically on small and medium-sized enterprises (SMEs). Publication II identifies new mechanisms for sales growth through the implementation of OBC BMs and analyzed the impact of OBC BMs adoption on profitability in investment product manufacturing SMEs. Publication III expands the existing academic understanding of the critical characteristic features required for OBC BM implementation in the MMs. Publication IV builds on this knowledge through an in-depth qualitative survey and interviews. From Publications III and IV, we specifically filtered and extracted data that directly addresses RQ1.
RQ 2 - How can MMs (SME and larger companies) design OBC BMs?	Publication III, compiles existing knowledge regarding the critical characteristic features necessary for OBC BM implementation in MM. The outcome was a conceptual framework comprising 16 key characteristic features essential for OBC BM implementation in MM. Publication also expands this framework through an extensive qualitative survey and in-depth interviews. This resulted in a novel understanding of the design process and its key components for developing OBC BMs, especially considering the framework of MMs. Publication IV investigates the significant challenges faced by large and SME MMs when offering OBC BMs. Additionally, it provides insights into

	strategies for mitigating these challenges. Finally, it highlights the specific benefits that OBC BMs can offer to SMEs.

Nonetheless, certain limitations must be acknowledged. First, the analysis is situated primarily within the machine manufacturing sector, which may restrict the generalizability of the findings to other industries. Second, while the combination of conceptual analysis and expert interviews strengthens the framework, the empirical evidence is still limited in scale, particularly regarding longitudinal data on performance outcomes. Third, SMEs represent a highly heterogeneous group, and the findings may not fully capture the diversity of strategies and contexts within this category.

1.4 Key Business Model Concepts in this dissertation

This section defines the central Business Model related concepts and terminology used in this thesis and its publications.

The servitization journey of MMs follows the Product-Service System (PSS) framework, transitioning from product-, use-, to result-oriented business models (BMs) (Tukker, 2004). Product-oriented BMs are investment-based, where the customer owns the machine and pays for services like maintenance. Use-oriented BMs include renting and leasing, where the manufacturer retains ownership (Tukker, 2004). Result-oriented BMs, also known as performance-based contracts (PBCs) or outcome-based contracts (OBCs), involve customers paying for delivered results while the manufacturer retains ownership (Liinamaa et al., 2016; Grubic & Jennions, 2018; Ng & Nurudupati, 2010).

Although OBCs are often classified as business models (Grubic & Jennions, 2018; Ng et al., 2009), they primarily address the value proposition that is, the promise of delivering specific outcomes such as uptime, performance, or cost savings, and therefore do not fully encompass all components of a business model, such as cost structure, key resources, and partnerships. In other words, while OBCs define what value is offered and to whom, they do not necessarily explain how that value is created and captured across the business ecosystem (Baines et al., 2020). In this dissertation, OBCs are defined as contractually based mechanisms that allow customers to pay according to delivered outcomes rather than machine ownership (Ng et al., 2009). To emphasize the broader managerial and organizational dimensions beyond the legal contract, the term OBC BM

is used to highlight the integration of contractual logic with business model elements such as value creation, delivery, and capture.

This dissertation identifies the benefits and risks of OBC BMs in the MM sector, as well as the key decision characteristics (DCs) that influence lifecycle profits and risks and presents a conceptual model to support MMs in the systematic design of OBC BMs.

The contractual component of an OBC represents the legally binding mechanism that links supplier compensation to predefined outcomes rather than to inputs or activities. In manufacturing contexts, these outcomes may include system availability, production volume, or quality performance. Schaefers et al. (2021) demonstrate that availability- and economic outcome-based contracts provide distinct benefits and risks, requiring careful allocation of responsibilities between buyer and supplier. They further show that industrial customers increasingly expect payment models tied to business-relevant outcomes, highlighting the contractual role of incentive alignment. Neely and West (2022) add that OBC contracts must incorporate governance mechanisms to adapt performance metrics and terms over time. Thus, while the business model articulates the overall logic of value proposition, creation, and capture, the contract operationalizes these principles through enforceable, outcome-linked agreements (Ng & Nudurupati, 2010).

This dissertation adopts OBC BM as the overarching umbrella term, which is largely equivalent to the concept of Pay-Per-X (PPX) business models. Within this framework, three sub-categories are distinguished: Pay-Per-Use (PPU), Pay-Per-Output (PPO), and Pay-Per-Outcome (PPOutcome). OBC can be divided in a similar manner to use/availability-based, output-based and (economic) outcome-based models (e.g. Böhm et al. 2016). In this dissertation, the term OBC is used specifically to refer to the contractual dimension, whereas OBC BM/PPX BM is used to denote the underlying business model logic. While different publications in the literature emphasize different terminologies, this dissertation integrates them under a unified framework to ensure conceptual clarity and comparability.

Pay-Per-Outcome is a result-oriented approach where customers pay based on achieved outcomes or performance improvements, rather than for product ownership or usage. This model shifts financial and operational risks from the customer to the provider, incentivizing suppliers to ensure efficiency, reliability, and optimal performance. Common applications include energy savings contracts, healthcare services, and industrial machinery, where payments are tied to measurable results such as cost reductions, productivity increases, or environmental benefits (Tukker, 2004; Uski et al., 2022).

The PPO business model is a performance-based approach in which customers pay based on the number of output units produced by a machine or system, rather than owning the equipment or paying for its usage time. This model incentivizes the provider to maximize efficiency, uptime, and quality, as revenue is directly tied to actual delivered output rather than equipment sales or service fees (Uski et al., 2022; Korkeamäki, 2021).
The PPU business model is a service-oriented approach where customers pay based on the actual usage time of a product or system instead of purchasing or leasing it. This model allows customers to access equipment on demand, reducing capital expenditures while transferring maintenance and operational risks to the provider (Uski et al., 2022; Böhm et al., 2016).

As discussed throughout this dissertation, OBC BMs are employed as a unifying concept to represent all business models illustrated in Illustration 2. This categorization functions as a conceptual lens through which the various "pay-per-something" (PPX) models examined in this dissertation are analyzed. The adoption of

this classification does not influence the dissertation's findings or conclusions, as it remains consistent with the research objectives and analytical framework.

Different terminology has been used across individual publications comprising this dissertation. In Publication I, term Pay-Per-Output Business Model was applied to investigate the implementation of such models within manufacturing SMEs. Publication II adopted the broader term PPX Business Model to examine mechanisms of sales growth and profitability among MMs. Publications III and IV employed the term OBC BM to reflect a dual focus on both the business model aspects and the contractual elements inherent to OBC BM arrangements.

In this dissertation, OBC BMs are contractual agreements in which the payment and value delivery are tied to the achievement of specific outcomes or performance results, rather than merely delivering products or predefined services. Instead of paying for input-based activities (e.g., hours of labor, spare parts), customers pay for the functional outcomes or capabilities that the provider guarantees to deliver. (Ng et al., 2009). In Publication I, from terminology point of view the focus was exclusively on Pay-per-Output business models. In Publication II, the scope was extended to include both Pay-per-Output and Pay-per-Use models, framed within the Pay-per-X BM (PPX BM) definition. Publications III and IV broadened the analysis further to encompass a range of delivered OBC BMs.

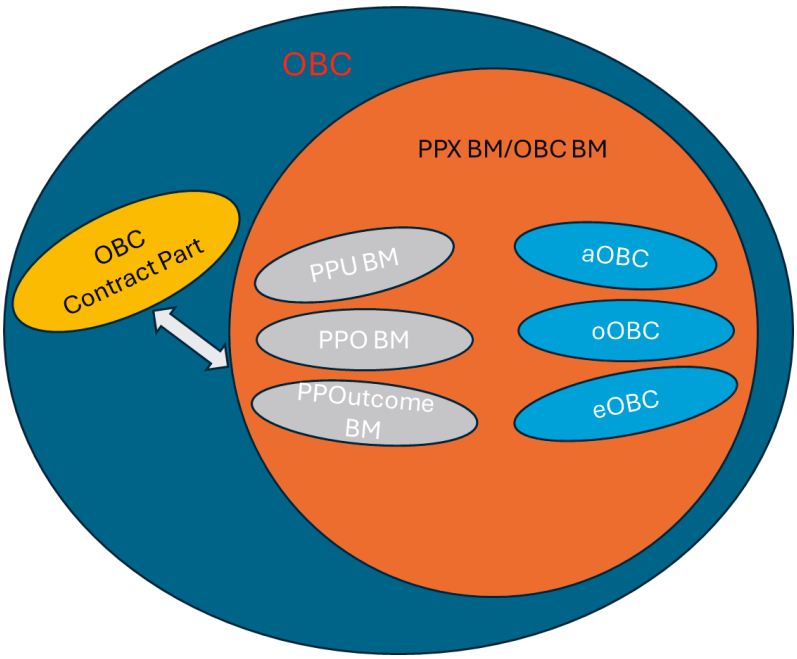
In this dissertation, several related terms are used to distinguish variations of outcome-oriented business models. Pay-per-Use (PPU) BMs refer to arrangements where customers are charged based on actual usage time or machine operation. Pay-per-Output business model (PPO BM) link payments to measurable production results, such as units produced. Pay-per-Outcome BMs (PPOutcome BM) extend this principle by tying payments to broader performance or outcome metrics, such as cost savings or product quality. Within the context of Outcome-Based Contracting business model (OBC BM), three specific forms are identified: availability-based OBCs (aOBC), which guarantee system uptime or performance; outcome-based OBCs (oOBC), which reward the achievement of predefined operational outcomes; and effectiveness-based OBCs (eOBC), which focus on end-user or business-level impacts, such as productivity or efficiency gains. (Grubic&Jennions, 2018; Kohtamäki et al., 2020). Summary of main BM concepts and definitions, used in this dissertation are listed in the following table 2.

Table 2. Summary of main BM Concepts and Definitions

Concept	Full Term	Definition	Core Logic	Typical Use in Machine Manufacturing
OBC BM	Outcome-Based Business Model	A business model where payment is tied to achieving agreed, measurable performance outcomes, with provider assuming performance risk. Including also contract part.	Payment for use, output or outcomes and other agreed deliverables.	Long-term performance contracts guaranteeing machine outcomes, supported by digital monitoring and service.
PPX BM	Pay-Per-X Business Model	Umbrella term for all PPx BMs. In this dissertation same as OBC BM. Including also contractual components. (See also next figure 2.)	Payment tied to a defined metric and/or other agreed deliverables.	Large scale of usage for all PPx BMs (PPU BM, PPO BM, PPOutcome BM). In this dissertation usage is the same with OBC BM.

PPU BM	Pay-Per-Use Business Model	Customer pays based on actual machine usage, such as operating hours or cycles.	Payment for usage of product, equipment or service.	Machine-as-a-Service or leasing models reducing upfront investment.
PPO BM	Pay-Per-Output Business Model	Customer pays based on produced output, e.g., items, tons, printed parts.	Payment for output or delivered measurable service and/or other rights.	Used when productivity or throughput drives customer value.
PPOutcome BM	Pay-Per-Outcome Business Model	Customer pays based on business-relevant, measurable outcomes such as uptime or efficiency.	Payment for strategic performance outcomes.	Used when outcomes create measurable customer value and require strong provider responsibility.
Revenue Model	—	Describes how a company generates income—its pricing mechanisms, revenue streams, and payment structures.	How money is earned.	Supports but does not fully define a business model; applies across offerings.
aOBC	Availability-Based Outcome-Based Contract	Customer pays based on the guaranteed availability, uptime, or readiness of the machine.	Payment for machine availability or uptime.	Common when customers prioritize reliability and continuous operation, e.g., uptime guarantees.
oOBC	Output-Based, Outcome-Based Contract	Customer pays based on the volume of output delivered by the machine (e.g., units produced).	Payment for quantity of produced output.	Used in high-volume or unit-based production settings, where output drives revenue.
eOBC	Effectiveness-/Efficiency-Based Outcome-Based Contract	Customer pays based on broader business effectiveness metrics—e.g., quality, energy efficiency, reduction in scrap, or productivity improvement.	Payment for improved business effectiveness or efficiency.	Suited for advanced servitization where efficiency, sustainability, or performance improvement is the key value.

Table 2. summarizes the key terms employed in this dissertation. Although these concepts are frequently used interchangeably in prior research, the literature indicates that their meanings and emphases vary depending on the analytical context. OBC BMs and PPX BMs both reflect a performance- and result-oriented value logic, yet they are not always fully synonymous. OBC BMs often emphasize contractual governance, risk allocation, and the provider's responsibility for achieving specified outcomes (Böhm et al., 2016; Hypko, Tilebein & Gleich, 2010), whereas PPX models can place stronger emphasis on performance-linked revenue structures and the operationalization of measurable use, output, or outcomes (Gebauer et al., 2017; Uski et al., 2022). However, given the focus and formulation of the research questions in this dissertation, these terms are treated as conceptually aligned. This approach enables a coherent examination of business models that prioritize realized outcomes, measurable performance, and value-in-use as the basis of value creation and capture.



Publication	Used BM Terminology	Focus of the used BM
I	Pay-per-Output	Output
II	Pay-per-X(PPX)	Output, Use
III	Outcome-Based Contract BM (OBC BM)	All Outcomes
IV	Outcome-Based Contract BM (OBC BM)	All Outcomes

Figure 2. Use of terminology on this dissertation and in publications.

1.5 Structure of the thesis

This doctoral dissertation consists of two parts, introduction, and publications. Chapter one introduces the background of thesis and explains the relevance and importance of the work and defines the research gap. The first chapter also clarifies key concepts and terms used in the thesis and supporting publications. Chapter two describes the status of knowhow in the scope of the thesis. Chapter three describes the main purpose of the thesis by introducing research questions, research strategy and data collection and analysis methods. Chapter four introduces individual publications and results. Chapter five answers research questions and explains the academic contributions of the publication to research questions. This chapter also conducts managerial implications, evaluates the dissertation and its limitations. In addition, chapter five proposes a potential focus for future research. The last part of the dissertation consists of 4 publications.

2 CONCEPTUAL AND THEORETICAL BACKGROUND

This chapter is structured to provide the background for the dissertation by developing a comprehensive understanding of how OBC business models are implemented in investment equipment manufacturing SMEs and large enterprises. To do so, the chapter draws on two main strands of existing research. Research on servitization and product-service systems (PSS) provides the foundation for RQ1, which examines how OBC BMs create opportunities and risks for manufacturing firms. This literature explains the transition from product-oriented to use- and result-oriented business models (Vandermerwe & Rada, 1988; Tukker, 2004; Baines et al., 2009) and highlights how performance-based revenue models and shared risk enable new forms of value co-creation (Ng & Nudurupati, 2010; Grubic & Jennions, 2018). In contrast, studies addressing firm size, resource constraints, and organizational characteristics are directly linked to RQ2, which investigates how these opportunities and risks differ between SMEs and large firms. Existing research on SME-specific servitization challenges points to structural limitations, resource scarcity, and strategic flexibility as factors shaping the adoption and design of OBC BMs. By linking these two strands of research to RQ1 and RQ2, the chapter positions OBC BMs within both the broader servitization literature and the firm-size-specific context.

Section 2.1 introduces the foundational concept of industrial servitization and outcome-based models, clarifying the differences between product-, use-, and result-oriented business models, and positioning OBC BMs as a distinct and advanced form of value creation tied to measurable outcomes. By drawing on the servitization and PSS literature, this section illustrates the mechanisms through which OBC BMs create opportunities and risks in manufacturing firms, particularly via pay-per-output models, value co-creation, and financial risk-sharing.

Section 2.2 examines the business model landscape within the SME context, emphasizing how firm size, structural characteristics, and resource constraints shape both opportunities and barriers in OBC BM implementation. This section explains how SME-specific features—such as agility, limited technical resources, and close customer relationships—differ from those of large companies and thereby influence the opportunities and risks associated with adopting OBC BMs.

Section 2.3 narrows the focus to the machine manufacturing sector, integrating existing research and industry-specific considerations to highlight the relevance and complexity of implementing OBC BMs in capital-intensive, digitally evolving manufacturing environments. This section contributes to the dissertation's research area by further contextualizing the mechanisms of OBC business model implementation in a sector characterized by complex risk-sharing and performance measurement. It also illustrates how company size interacts with sector-specific demands, shaping the feasibility and design of OBC BMs.

Together, these three sections lay the conceptual groundwork for the empirical investigations in later chapters and establish the relevance, feasibility, and impact of OBC BMs in SMEs and large companies in the machine manufacturing sector.

2.1 Industrial services and business models

Baines et al. (2007) illustrates the shift from traditional product-based sales to advanced service-driven business models, highlighting increasing levels of service integration, risk-sharing, and outcome-based approaches. This transition reflects the broader trend of servitization, where manufacturers move beyond simply providing products to deliver long-term value through services.

At the base level, businesses focus predominantly on product provision, including direct sales and spare parts supply, with the primary objective being product availability and minimal additional services (Reim et al., 2024; Kohtamäki et al., 2025). As companies mature in their service strategies, maintenance-oriented services become central e.g. helpdesk support, repairs, overhauls, scheduled maintenance, and condition monitoring (Kohtamäki et al., 2025). These services are instrumental in extending equipment lifespan, enhancing reliability, and reducing customer downtime (Spadafora, 2025). Moreover, digital servitization studies show that manufacturers leveraging remote monitoring and AI-driven maintenance tools strengthen their service offerings by shifting from reactive to predictive maintenance regimes (Kohtamäki et al., 2025), further embedding maintenance services as key pillars of their value propositions.

At the advanced level, businesses adopt outcome-based models in which revenue generation is tied to delivered performance rather than asset ownership. This category includes customer support agreements, long-term service contracts, risk- and revenue-sharing arrangements, and usage-based revenue models (Ng & Nudurupati, 2010; Kuismanen et al, 2024). In these models, the manufacturer assumes greater financial and operational responsibility, ensuring that customers benefit from performance-driven outcomes, such as availability, output, or cost savings, rather than mere product possession (Grubic & Jennions, 2018; Baines et al., 2020). Recent studies emphasize that such models require advanced digital capabilities, real-time performance monitoring, and collaborative risk management to align incentives and ensure long-term mutual value creation (Knecktys et al., 2022; Kohtamäki et al., 2025).

This dissertation differentiates rental and leasing arrangements from OBC BMs, as the former lacks key characteristics that define outcome orientation. Rental and leasing models are based on asset access or availability, with customers paying for usage over a fixed term, regardless of actual performance or outcomes. As such, they do not include the variables, such as performance metrics or results, that influence revenue streams in OBC BMs. The core value proposition in rental and leasing lies in providing access to the asset, whereas in OBC BMs, the value is derived from the asset's performance in delivering a specific outcome (Ng & Nudurupati, 2010; Visnjic et al., 2016). Moreover, risk allocation differs significantly: in rental and leasing, the customer bears most of the operational and performance risk, while in OBC BMs, the provider assumes a greater share of risk, as payment is directly tied to outcome delivery (Baines & Lightfoot, 2014; Spring & Araujo, 2017). In fact, if performance falls short in an OBC arrangement—such as reduced uptime or output—the provider may face financial penalties or reduced compensation, reinforcing a performance-driven incentive structure (Grubic & Jennions, 2018). Therefore, while rental and leasing models may represent steps on the servitization journey, they do not meet the definitional or functional criteria of true OBC BMs as adopted in this dissertation.

As-a-service business models provide customers access to a product or capability through subscription or usage-based payments instead of ownership, with the provider retaining responsibility for operation and maintenance (Tukker, 2004; Paiola & Gebauer, 2020). Good examples as-a-service business models are

Software-as-a-Service or Equipment-as-a-Service. These models shift expenditures from CapEx to OpEx and place responsibility for operation and basic performance on the provider, making them effective for standardized, digitally delivered services. However, this logic is generally not sufficient for OBC BMs. As-a-service models focus primarily on access or usage (e.g., monthly fees or pay-per-use) and include only limited risk transfer, whereas OBC BMs tie payment directly to operational results such as uptime, throughput, or quality. Achieving these outcomes requires deep integration into the customer's production processes, shared performance responsibilities, and management of significant asset, operational, and performance risks. Because simple as-a-service arrangements do not account for this complexity or provide the governance mechanisms needed to guarantee outcomes, they are typically insuffient as a foundation for OBC BM, espicially in capital-intensive industrial settings.

Machine-as-a-Service (MaaS), one of the as-a-service models, refers to a servitized business model in which industrial machinery is no longer sold as a physical product but is delivered as a service, with customers paying for access, usage, or outcomes rather than ownership. In MaaS models, the manufacturer typically retains ownership of the equipment and assumes responsibility for maintenance, operation, performance, and often uptime guarantees. This shifts the value logic from transactional equipment sales toward continuous service provisioning and lifecycle value creation (Tukker, 2004; Reim, Parida & Sjödin, 2015). MaaS builds on the principles of Product-Service Systems and Equipment-as-a-Service, where machinery is offered through subscription, pay-per-use, pay-per-output, or performance-based pricing mechanisms (Paiola & Gebauer, 2020). Enabled by digital technologies such as IoT connectivity, remote monitoring, predictive analytics, and smart services, MaaS allows manufacturers to ensure performance while lowering customers' capital burdens and improving operational flexibility (Porter & Heppelmann, 2015). MaaS extends PPX by bundling machinery with broader digital services, maintenance, and operational support, thereby offering equipment access as an integrated service rather than a product, with payment tied to usage, subscription, or basic performance metrics (Paiola & Gebauer, 2020).

OBC BMs fundamentally reshape a firm's revenue and cost–revenue logic because payment is no longer tied to product transactions or usage, but to the achievement of measurable outcomes such as availability, throughput, or quality (Ng & Nudurupati, 2010; Selviaridis & Wynstra, 2015). Under OBC BM arrangements, revenue becomes performance-dependent, variable, and contingent on the provider's ability to deliver guaranteed results, while the cost structure shifts toward lifecycle responsibility, including maintenance, monitoring, spare parts, and risk absorption. This creates a tighter coupling between cost efficiency and revenue generation, making profitability highly sensitive to operational performance and digital capabilities. Although revenue models and cost–revenue models are central components of any business model, defining how value is monetized and how profit emerges from the balance between service delivery costs and performance-based income, the present dissertation concentrates less on cataloguing revenue model types and more on how providers can improve profitability and growth under OBC BM conditions. This emphasis follows the dissertation's research questions, which focus on the benefits and risks of adopting OBC BMs and on how such models can be effectively designed. The analysis therefore concentrates on the mechanisms, capabilities, and enablers, such as digitalization, risk management, operational excellence, and performance transparency, that allow machine manufacturers to operate OBC BMs successfully and scale them economically. In this way, revenue and cost–revenue logic are acknowledged as important background factors, but the core contribution of the dissertation lies in identifying how profitability and growth can actually be achieved in practice within OBC BM implementations.

This evolution underscores the growing importance of servitization, enabling manufacturers to shift from transactional sales to long-term customer relationships. By moving towards service-based models, businesses not only create new revenue streams but also enhance customer satisfaction, improve operational efficiency, and foster stronger lifecycle-based commitments. (Baines et al., 2007)

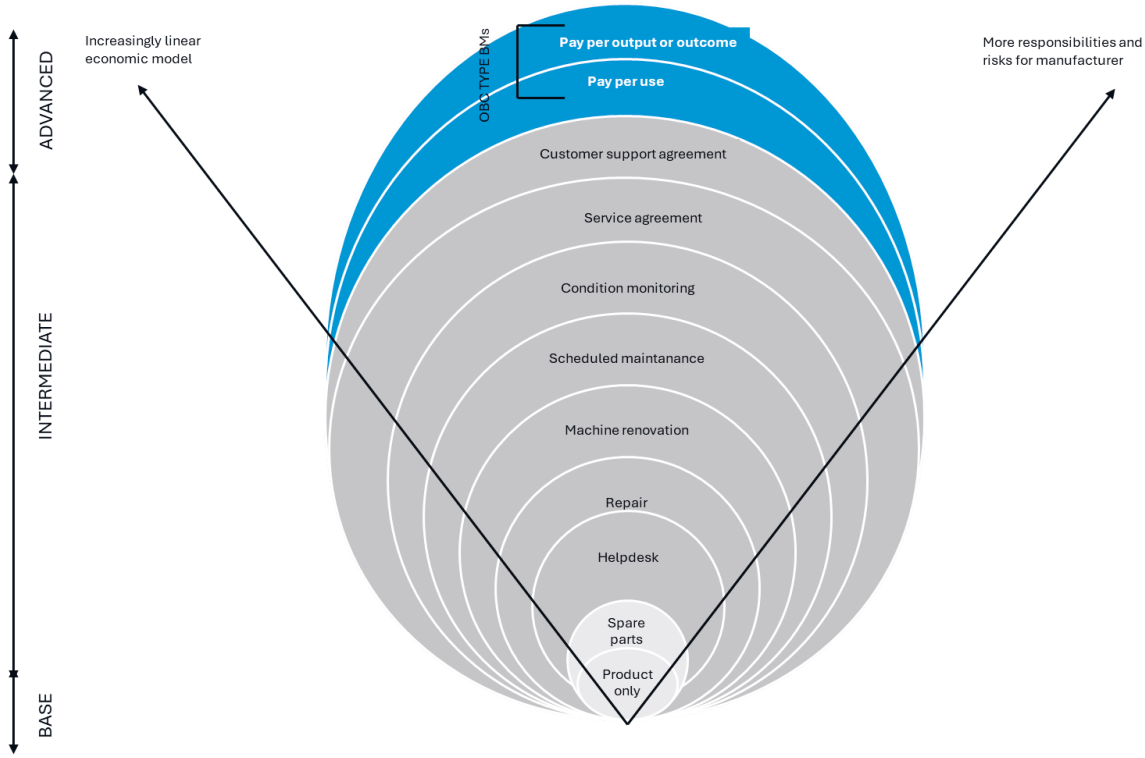


Figure 3. Levels of scopes of supplies in MMs (Adapted from Baines et al., 2007)

In the service-dominant logic framework, businesses have transitioned from simply selling products to enabling customers to achieve their desired outcomes (Ng et al., 2009). This shift reflects the growing emphasis on servitization as a strategic approach, where suppliers expand their role beyond product provision to deliver integrated services that enhance customer value and operational efficiency.

Servitization, which broadly defines the shift from selling products to offering integrated product-service solutions; very broadly speaking there are three types of business models: product-oriented, use-oriented, and result-oriented (Tukker, 2004), collectively referred to as product-service systems. Product-oriented BMs involve customer ownership of the machine, with manufacturers providing additional services such as maintenance at an extra cost.

Use-oriented BMs retain manufacturer ownership of the asset while customers pay for access, typically through rental, leasing, or sharing arrangements. Although these models represent a step away from traditional product sales, they are not considered OBC BMs. In use-oriented BMs, payments are tied to time or usage rather than the actual outcomes delivered, meaning that customers continue to bear most of the performance and operational risks (Tukker, 2004; Baines & Lightfoot, 2014; Nyvall, 2023). Such models are often viewed as transitional forms in the servitization journey, enabling firms to move gradually from product provision toward more advanced, performance- and outcome-based offerings (Adrodegari & Saccani, 2017; Baines et al., 2020).

In contrast, result-oriented BMs, also referred to as performance-based (Hypko et al., 2010b; Liinamaa et al., 2016) or outcome-based business models (Grubic & Jennions, 2018), tie customer payments directly to achieved outcomes, such as uptime, energy efficiency, or output levels. In these models, the provider assumes greater responsibility and risk for delivering results, and revenue is linked to performance metrics rather than asset availability. Therefore, while use-oriented BMs represent an intermediate step on the servitization spectrum, more advanced than pure product sales, they do not meet the defining criteria of OBC BMs. OBC BMs require a deeper integration of performance risk, value co-creation, and result-based compensation (Tukker, 2004; Baines et al., 2017).

In pay-per-service unit models, customers are charged based on machine usage, such as tractor operating hours in farming, or on the number of output units produced, such as photocopies. Recent studies have referred to time-based payments as pay-per-use (Gebauer et al., 2017; Uski et al., 2022) and availability OBC BMs (Böhm et al., 2016; Grubic & Jennions, 2018; Korkeamäki, 2021), while output-based payments are known as output OBC BMs (Korkeamäki, 2021) or pay-per-output (Uski et al., 2022). Functional result models focus on value-added outcomes, such as energy savings from using a generator, and are commonly referred to as economic OBC BMs (Uski et al., 2022) or pay-per-outcome models (Böhm et al., 2016; Grubic & Jennions, 2018; Korkeamäki, 2021). In a result-oriented BM, the supplier assumes greater responsibility for the customer's business operations. This vertical integration necessitates the development of new capabilities by the supplier to effectively manage these additional responsibilities (Yang et al., 2018). With the higher level of tangible investment required, especially in industries like MM (for example compared to the software industry), a much wider range of capabilities is needed. Manufacturing managers are advised to gradually increase the share of outcome-based services in their business models, rather than attempting a full-scale transformation all at once (Jovanovic et al., 2019).

The delivery of advanced services affects profit margins in several ways. Economies of scale are reduced as manufacturers move away from centralized production, increasing complexity and delivery costs. Additional resources, such as specialized personnel, skills, and technology, are often required, raising overhead expenses. Manufacturers may also risk overpromising in their service offerings, underestimating costs or being overly ambitious, which can significantly erode profit margins. Furthermore, contracts for advanced services frequently include penalty clauses for poor performance, directly impacting profitability in cases of non-compliance. (Baines et al., 2007)

Overall, this dissertation examines advanced OBC BMs, including pay-per-output, pay-per-outcome, and pay-per-use models. However, it does not focus on leasing or renting, even though leasing is sometimes categorized under OBC BMs. This dissertation contributes to the body of knowledge by advancing research streams in several key areas: the development of frameworks for designing OBC BMs, strategies for implementation and evaluation of these models, and an exploration of OBC BMs within the context of SMEs. Additionally, this

dissertation contributes to a deeper understanding of the mechanisms driving sales growth and profitability by enhancing the evaluation of risks and benefits associated with the implementation of OBC BMs.

2.2 Business model research in SME context

Small and medium-sized enterprises (SMEs), defined by the European Commission as companies with fewer than 250 employees and an annual turnover below €50 million (European Commission, 2020), represent a crucial yet underexplored context in business model (BM) research. While the literature on business model innovation (BMI) and servitization has largely focused on large corporations, SMEs exhibit distinct structural, behavioral, and strategic characteristics that merit separate theoretical and empirical attention.

SMEs typically operate with flat organizational structures, informal processes, and direct involvement of owner-managers in strategic decisions (Storey, 1994). These features contribute to their agility and responsiveness, allowing them to act quickly in response to market shifts. They often display a greater willingness to take calculated risks compared to larger companies (Vossen, 1998), which can be particularly advantageous when exploring novel or hybrid business models, including outcome-based business models (OBC BMs). SMEs are also frequently embedded in niche markets and maintain close, trust-based relationships with customers, enabling iterative development and co-creation in BM innovation processes (Codini et al., 2023).

However, SMEs also face persistent constraints that affect BM design and implementation. These include limited financial resources, constrained internal R&D capacity, and a shortage of managerial and technological expertise (Ayyagari et al., 2007; Liu & Yang, 2019). Financing is especially challenging; SMEs often rely heavily on bank loans, making them vulnerable to credit market fluctuations. In terms of digitalization, they tend to lag behind larger companies in adopting advanced technologies such as AI, Industry 4.0 solutions, and analytics, largely due to capability and cost barriers (Müller et al., 2018). These constraints not only limit innovation but also shape the pathways through which BMI occurs in small companies.

Compared to larger companies, SMEs face general challenges due to limited internal and external knowledge capabilities (Liu & Yang, 2019), small product ranges and market size, limited opportunities for economies of scale, informal and flat organizational structures and limited management leadership and strategic capabilities (Pati et al., 2018; Radas et al., 2009). These general challenges impacts also BM designing and implementation.

There are key differences between SMEs and large enterprises, which demonstrate the need for SME-oriented research e.g. in servitization and BM-related research. For example, (Müller et al., 2018) summarizes SME characteristics into eight groups: finance, technical resources, product specialization, standards, organizational culture, employee participation, alliances, and collaboration. Studies also indicate that Industry 4.0 and IIoT research predominantly focuses on large enterprises (Ladas et al., 2019), with limited attention to SMEs (Jiang et al., 2007).

There are academic studies (Kowalkowski et al., 2013; Adrodegari & Saccani, 2017; Kolagar et al., 2022) which have examined servitization from the SME perspective. Research on service models has largely overlooked how company size influences service development (Gebauer et al., 2020). Bhamra et al. (2018) highlight that SMEs have specific needs in terms of service and business model development, emphasizing the importance of customized information to support the implementation of product-service systems. Oliva and Kallenberg

(2003) suggest that companies should enter the service market by serving an installed base; however, SMEs often operate through distributors and installers, limiting their direct access to their installed bases. This structural limitation can make it more challenging for SMEs to establish and scale service-oriented business models.

From a business model perspective, the servitization of SMEs entails more than the integration of services into existing offerings; it requires a fundamental reconfiguration of value creation, delivery, and capture mechanisms. As Bhamra et al. (2018) emphasize, SMEs require tailored guidance and contextualized knowledge to effectively develop product-service systems (PSS), highlighting the need for business model frameworks that accommodate their specific structural and operational constraints.

In the context of OBC BMs, these challenges are particularly salient. OBC BMs, which link revenue to the realization of predefined outcomes rather than the sale of products or usage, demand not only new capabilities in performance measurement and risk management but also close customer relationships and access to usage data. However, SMEs often rely on intermediaries such as distributors and installers, which can limit their direct interaction with end-users and their installed base (Oliva & Kallenberg, 2003). This structural disconnection may hinder the deployment and scalability of OBC BMs, as a performance-based business models.

Consequently, there is a growing need for more nuanced research that bridges servitization, business model innovation, and the specific conditions under which SMEs operate. Understanding how these firms can overcome structural and capability-related barriers through digitalization, ecosystem partnerships, or hybrid service strategies, is essential for facilitating their transition toward sustainable and competitive service-based business models. Recent studies emphasize that SMEs often face constraints in resources and ecosystem integration, requiring collaborative and digitally enabled approaches to develop viable service offerings (Kohtamäki et al., 2025).

While some studies examine servitization and advanced business models in manufacturing from an SME perspective (Müller et al. 2019) (Mittal et al., 2018) they emphasize the need for dedicated SME-focused business model research due to their unique characteristics. A few also consider the capital goods and investment product sectors when analyzing SMEs (Gebauer et al. 2017). Clearly defining the interrelationships among capabilities can help streamline investments, enhance employee expertise, and strengthen decision-making, effectively addressing some of the key challenges faced by SMEs (Mittal et al., 2019).

Given these insights, it is crucial to study business models, especially OBC BMs from an SME perspective to ensure the relevance of results and implications to SME-size companies. Research in SME business models reveals how these companies successfully implement servitization, digital transformation, and outcome-based contracting (OBCs) to remain competitive against larger companies (Chesbrough, 2010; Parida et al., 2014). For SMEs, new type of business models helps in developing strategies for resilience, adaptability, and financial sustainability, ensuring business continuity during crises (Doern et al., 2019). By focusing on customer outcomes rather than just product ownership, SMEs can create stronger value propositions that appeal to customers looking for performance-based solutions rather than capital expenditures (Kohtamäki et al., 2020). Traditional SMEs struggle to compete with large companies in terms of scale, pricing, and brand recognition. In OBC BMs, risks associated with equipment performance and maintenance are shifted from the customer to the supplier, creating a strong incentive for the SME to optimize operations, minimize downtime, and deliver high-quality service (Hypko et al., 2010). Also, from an environmental point of view SMEs offering outcome-

based solutions reduce waste and material consumption while enhancing product longevity, aligning with environmental regulations and sustainability goals (Tukker, 2015).

In this dissertation studying OBC BMs from an SME perspective is important to ensure research relevance and applicability (Gebauer et al., 2010). SMEs adopt servitization and digital transformation to remain competitive against larger companies (Parida et al., 2014). OBC BMs enhance resilience and financial sustainability, particularly during times of crisis (Doern et al., 2019). By focusing on customer outcomes, SMEs can deliver stronger value propositions (Kohtamäki et al., 2020). Furthermore, OBC BMs support sustainability by reducing waste and extending product lifecycles (Tukker, 2015).

Research on OBC BMs must go beyond general analysis to provide actionable, SME-specific guidance. SMEs often face constraints in resources, digital capabilities, and managerial expertise, which differentiate them from large companies and affect their ability to adopt complex servitization models (Gebauer et al., 2010). Applying generic business model frameworks without adaptation risks overlooking these unique challenges.

Several studies have addressed this by focusing on SMEs in capital goods and investment product sectors, where outcome-based approaches are increasingly relevant due to the emphasis on performance, customization, and long-term service relationships (Gebauer et al., 2010; Gebauer et al., 2017). However, SMEs require tailored strategies that reflect their scale and capabilities.

OBC BMs offer SMEs significant competitive advantages by transitioning from traditional product ownership models to performance-based value delivery systems. This shift enables SMEs to establish stronger customer relationships, enhance financial stability, and differentiate themselves in dynamic markets. The integration of servitization, digitalization, and data-driven service models further empowers SMEs to secure long-term contracts and optimize revenue streams. For instance, Mittal et al. (2024) highlights that the adoption of OBC BMs in SMEs necessitates capabilities such as data analytics and remote monitoring, which are facilitated by digital technologies. These capabilities not only support the implementation of OBC BMs but also contribute to improved customer satisfaction and operational efficiency.

Table 2. presents a structured overview of critical internal factors influencing the adoption and implementation of OBC BMs in MMs, categorized under six thematic areas: Finance, Technical Resources, Product Specialization, Standards, Organizational Culture, and Collaboration. Each category lists specific capabilities or barriers that companies may encounter when transitioning to OBC BMs. These factors are substantiated by references from existing literature, providing theoretical grounding and empirical support. For instance, financial elements such as risk aversion and investment capacity highlight the importance of robust capital structures in enabling performance-based service delivery (Rosenbusch et al., 2011). Technical resources like data collection, predictive maintenance, and digital integration underscore the necessity for technological readiness (Bhamra et al., 2018). Product specialization emphasizes the role of tailored solutions and niche expertise, while adherence to industry standards ensures compliance and interoperability (Parida et al., 2012). Organizational culture reflects internal readiness, including customer-centric mindsets and openness to change (Mittal et al., 2025). Lastly, collaboration stresses the importance of trust and information sharing between stakeholders. In Table 2, the two middle columns indicate whether each parameter has a direct or indirect link to OBMs. Parameters classified as direct exert a stronger and more immediate influence on the implementation of OBMs within SMEs. However, the indirect parameters also provide valuable insights into the specific characteristics and contextual factors that shape SME adoption of OBM BMs.

Table 3. SME-Specific Features in BM Implementation.

Category	Benefits of the small size	Challenges because of the small size	Direct OBC BM connection	Indirect OBC BM connection	Source
Finance					
Less financial resources		x			Müller et al., 2013
To adopt OBC, penalty system more needed to mitigate risks.	x				Adrodegari et al., 2017
High upfront investment for digital infrastructure, service capabilities, and equipment ownership can strain SME budgets.		x			Mittal et al., 2025
Implementing OBC requires upfront investment in digital systems, risk-sharing mechanisms, and skilled staff, which can strain SME budgets.		x			Rosenbusch et al., 2011
Business capabilities					
Move from transactional product sales to recurring income.	x		x		Adrodegari et al., 2017
Competitive differentiation: Enables smaller firms to stand out in saturated product markets.	x		x		Adrodegari et al., 2017
SMEs leverage intimate customer understanding to co-create solutions, a core success factor for OBC BM.	x		x		Pati et al., 2018
SMEs' focus on niche markets and custom solutions aligns well with outcome-based value propositions.	x			x	Rosenbusch et al., 2011
Limited contract management skills		x		x	Oliva and Kallenberg, 2003
Technical resources					
Less techical capabilities and resources.		x	x		Müller et al., 2018
Specific needs in terms of service and BM development, emphasizing the importance of customized information to support the implementation of PSSs.	x	x			Bhamra et al., 2018
Difficulty in implementing IoT-enabled monitoring, digital twins, and outcome measurement systems.		x	x		Mittal et al., 2025
Limited resources		x	x		Pati et al., 2018
Product specialization					
SMEs often operate through distributors and installers, limiting their direct access to their installed bases.				x	Oliva and Kallenberg, 2003
Fostering the customer relationship with fast reaction to evolving market conditions		x		x	Parida et al., 2012
Small product ranges and market size	x	x	x		Pati et al., 2018
SMEs' focus on small, incremental innovations supports continuous improvement—important for managing outcome-based performance.	x			x	Radas et al., 2009
Standards					
Less resources to fullfill technical standards.		x	x		Müller et al., 2018
Organizational culture					
SME MMs have challenges associated with fluctuating customer conditions, difficulties in cost estimation, and customer reluctance to adopt OBC BMs.		x	x		Adrodegari et al., 2017
SMEs often innovate quickly to differentiate themselves in competitive markets, which supports outcome-based offerings.	x		x		Mittal et al., 2025
Strong personalized ties allow SMEs to build trust and co-create value with clients, critical for OBC BM success.			x		Mittal et al., 2025
Entrepreneurial Orientation: Many SMEs have a flexible, customer-centric mindset, facilitating service innovation	x		x		Pati et al., 2018
Collaboration					
Harder to establish networks to implement OBC BM.		x	x		Müller et al., 2018
Flat organizational structures and limited management leadership and strategic capabilities	x	x	x		Pati et al., 2018
SMEs need partnerships or networks to access necessary technical and managerial expertise for OBC BM.		x		x	Radas et al., 2009
Challenges due to liabilities		x	x		Rosenbusch et al., 2011
Flat hierarchies enable quick responses to performance deviations or customer feedback.	x		x		Mittal et al., 2025
Organizational resistance: Internal shift from product-selling mindset to service-oriented culture is harder with limited resources.		x	x		Adrodegari et al., 2017
Closer Supplier-Customer Ties: SMEs can build strong trust-based relationships, enabling co-creation of outcome-based value	x		x		Uski et al., 2025

Moreover, existing literature indicates that research on Industry 4.0 and the Industrial Internet of Things (IIoT) has predominantly centered on large enterprises (Ladas et al., 2019), with significantly less attention given to SMEs (Jiang et al., 2007). While some studies explore servitization and advanced business models within the manufacturing sector—particularly in relation to service-oriented business strategies—these investigations often adopt an SME-specific lens (Müller et al., 2018; Mittal et al., 2018). This perspective is particularly relevant given the unique structural and operational characteristics of SMEs.

However, research also acknowledges that small size can result in competitive advantages also through business model development and implementation through flexibility, strategic agility and increased opportunities for innovation (Nooteboom, 1994; Vossen,1998). There is a large amount of literature on business models, this has predominantly focused on large companies (George and Bock, 2011, Pati et al., 2018), with limited research exploring the key defining features of SME business models and approaches to business model innovation within SMEs. SME size company face unique challenges due to liabilities of smallness and constrained resources (Rosenbusch, Brinckmann, & Bausch, 2011). These characteristics, inherent in SMEs, together with SME heterogeneity will impact their business model development, design, associated value drivers and processes (George and Bock, 2011, Pati et al., 2018) and also impact their ability to engage in business model innovation.

OBC BMs are increasingly recognized as vital for small and medium-sized enterprises (SMEs) aiming to enhance competitiveness, financial stability, and customer relationships. By shifting from traditional product ownership to performance-based value delivery, SMEs can better align their offerings with customer outcomes, fostering long-term partnerships and recurring revenue streams.

Research indicates that adopting OBC BMs enables SMEs to differentiate themselves in dynamic markets. For instance, Wirth et al. (2024) highlight that integrating service-oriented and data-driven business models allows SMEs to offer smart Product-Service Systems (PSS), combining products and services to meet specific customer needs. This integration not only enhances customer satisfaction but also opens new avenues for revenue generation.

Furthermore, digital servitization, leveraging digital technologies to enhance service offerings, plays a crucial role in the successful implementation of OBC BMs. Lamperti et al. (2023) emphasize that digital servitization strategies enable SMEs to innovate their business models, escape market disruptions, and maintain competitiveness. By adopting digital tools and platforms, SMEs can offer more personalized and efficient services, aligning closely with customer expectations. In summary, OBC BM research is essential for SMEs as it provides insights into transforming traditional business models towards more resilient, customer-focused, and digitally integrated frameworks. This transformation is key to achieving sustainable growth and competitiveness in today's rapidly evolving markets.

2.3 OBC BMs in machine manufacturing companies

OBC BMs are transforming industries by aligning service providers' incentives with measurable outcomes, fostering innovation, and enhancing efficiency. OBC BMs can be a game-changer in Machine Manufacturing (Kuismanen et al, 2024).

In the manufacturing sector, an OBC BM is defined as a service where customers acquire certain property rights to an asset with limited usage freedom for a specified period, while ownership burdens remain with the provider (Wittkowski et al., 2013). This definition highlights the customer perspective, emphasizing access without ownership. From the manufacturer's standpoint, the earning logic of OBC BMs falls into three categories: pay-per-use, pay-per-output, and pay-per-outcome models.

OBC BMs have been widely studied across various sectors, including the software industry (Weinhardt et al., 2009), B2C product manufacturers like washing machines (Manninen et al., 2018), and manufactured products such as copiers and printers (Ardolino et al., 2018). These sectors benefit from economies of scale, making OBCs more scalable. However, B2B manufacturers producing critical equipment, such as air compressors or jet engines, face higher risks and complexities when implementing OBC BMs (Schaefers et al., 2021).

OBC BM is result-oriented BM. Result-oriented BMs represent a category wherein the ownership of the machine remains with the manufacturer, while the customer compensates the manufacturer based on the results or outcomes delivered by the machine. These models are also commonly referred to as performance-based contracts (Hypko et al., 2010b; Liinamaa et al., 2016) and outcome-based contracts (Grubic & Jennions, 2018).

Tukker (2004) further classifies result-oriented BMs into three primary categories: activity management or outsourcing services, pay-per-service units, and functional results. Under the pay-per-service unit model, customers are charged based on the duration of machine usage (e.g., hours of operation) or the number of output units generated. Recent studies have introduced additional terminologies such as pay-per-use (Uski et al., 2022; Gebauer et al., 2017) and availability OBC BMs (Böhm et al., 2016; Grubic & Jennions, 2018; Korkeamäki, 2021) to describe instances where customers pay according to usage time, such as the number of hours a tractor operates to harvest agricultural produce. Conversely, output OBC (Korkeamäki, 2021) and pay-per-output (Uski et al., 2022) describe contracts where payments are based on the number of output units, such as the number of copies produced by a photocopier. The functional results category focuses on the added value provided by the service, such as energy savings achieved from a generator offered under an OBC BM. Contemporary literature uses terms like economic OBC (Uski et al., 2022) and pay-per-outcome (Grubic & Jennions, 2018; Korkeamäki, 2021) to refer to such models.

The increasing complexity of industrial equipment has been a significant development in recent years (Menon, 2020; Raddats et al., 2016). This trend has been further accelerated by digitalization, which has led to the widespread integration of more complicated automation systems and an increase of software part in MM. This development means that MMs are facing more difficulties in acquiring the requisite expertise, technical capabilities, and tools necessary for the in-house maintenance of their production equipment. Furthermore, the extended life cycles of machines further intensify these challenges, as organizations must sustain maintenance and servicing capabilities throughout the entirety of the equipment's operational lifespan (Korkeamäki, 2021). In addition, the need for continuous technological advancements necessitates that MMs possess the capability to upgrade industrial equipment to align with emerging technological developments (Khan et al., 2024).

Early frameworks for OBC BM design emerged about 15 years ago, particularly in the absence of Industry 4.0 technologies and sustainability concerns. Hypko et al. (2010) and Lay et al. (2009) developed a PSS(Product Service Systems)-related conceptual model incorporating seven critical OBC DC: (1) ownership of machinery during the contract period (2) ownership of machinery after the contract period, (3) responsibility for

maintenance personnel, (4) responsibility for operational personnel, (5) payment model, (6) location of operation, and (7) exclusivity of operation. These criteria were applied to various service-based models, such as leasing, performance-based contracting, and product-life extension services, primarily in B2B manufacturing. Their work systematically structured OBC BM design-related DC and frameworks tailored to manufacturing industries. Additionally, they empirically analyzed emerging business models, offering a structured approach for manufacturers transitioning to service-based concepts. This dissertation builds upon their findings, further refining the major DC for detailed OBC BM design.

The transition from investment-based to service-based business models introduces significant considerations for lifecycle profit and risk management in MMs (Knecktys et al., 2022). Traditionally, revenue was generated through product sales, whereas OBCs emphasize service delivery and guaranteed outcomes. This model shifts considerable risks from the buyer to the supplier, as payment depends on achieving the promised results. Moreover, MMs may assume responsibilities beyond traditional manufacturing roles, including machine operation, maintenance, and even raw material logistics (Uuskoski et al., 2023; Korkeamäki et al., 2022). Without a defined set of DC, MMs may overlook critical factors affecting profitability and risk mitigation when designing OBC BMs. For instance, they may fail to consider third-party ownership or leasing options, increasing financial exposure (Uuskoski et al., 2023). Consequently, inadequate decision-making frameworks can hinder MMs from successfully transitioning to OBCs (Sassanelli et al., 2020).

According to Schäfers et al., while organizational objectives such as cost reduction and supply reliability are central to purchasing OBC BMs, the individual goals of decision-makers also significantly influence the process. A key concern is the risk of personal accountability for potential issues arising during OBC implementation and operation. Contrary to existing research, which emphasizes the shift of operational risk from the customer to the supplier, their study suggests that customers perceive heightened individual and organizational risks when adopting OBCs. Therefore, OBC BM sales strategies should address both levels of decision-making concerns and prioritize trust-building in the supplier's capability to deliver and manage OBC BMs effectively. (Schaefers et al., 2021)

For the purposes of this dissertation, OBC BMs are utilized as a unifying term to describe comparable BMs and services. Furthermore, OBC BMs are categorized into three distinct types: availability, output, and economic OBC BMs. Within scientific literature, OBCs are frequently equated with BMs (Grubic & Jennions, 2018; Ng et al., 2009), although many studies only address selected aspects of a BM. For instance, while OBC-related research often emphasizes value propositions, it may overlook other critical components of the business model canvas (BMC), such as cost structure, key partners, and customer relationships.

Research on the design and characterization of OBC BMs, particularly for manufacturing industries (MMs), remains relatively limited. While studies exist on generic OBC BM design and configuration, specific investigations into MMs' readiness to adopt OBC BMs are scarce (Adrodegari & Saccani., 2017; Ziaee Bigdeli et al., 2018; Glas et al., 2018). Some research streams have explored capabilities, barriers, and enablers in OBC implementation (Bock and Weiner, 2018; Selviaridis and Wynstra, 2015). Identified challenges include high capital investment, long payback periods, intellectual property protection, ensuring desired outcomes, and continuous innovation. Revenue-related considerations for product-service systems (PSS) in MMs, automation, and transportation have also been analyzed (Adrodegari et al., 2017).

2.4 Business model innovation and OBC BM design

The design phase within Business Model Innovation (BMI) is essential for enabling OBC BMs, as it lays the groundwork for aligning business offerings with customer needs, ensuring operational feasibility, and facilitating long-term value creation. While SMEs often use design to differentiate in competitive markets and stabilize revenue through service-based offerings, larger companies focus on scaling outcome-oriented solutions and optimizing performance across complex value networks (Michalik, 2019).

The BMI process, adapted from the Cambridge Business Model Innovation framework (Brownlow et al., 2015), typically unfolds in four phases: initiation, ideation, integration, and implementation. These stages encompass more granular activities such as opportunity identification, concept development, prototyping, experimentation, piloting, launch, and adjustment. Business model innovation (BMI) refers to the intentional process of redefining how an organization creates, delivers, and captures value, often by challenging established assumptions about customers, value propositions, revenue structures, and key activities.

This structured approach provides a pathway for companies to move from recognizing market challenges to successfully deploying and refining new business models. In the context of OBC, where the emphasis shifts from product ownership to outcome delivery, this structured process becomes particularly critical.

OBC BMs represent a fundamental transformation in how value is created and captured. Rather than selling products or services outright, companies are compensated based on the achievement of specific, measurable outcomes—such as machine uptime, energy efficiency, or productivity improvements. This transformation requires business models to be redesigned from the ground up, beginning with a clear and coherent value proposition. During the design phase, companies must identify which outcomes matter most to their customers, how these outcomes will be measured, and how they will shape pricing models and service delivery mechanisms (Baines & Lightfoot, 2014; Kindström & Kowalkowski, 2014).

Design also involves reconfiguring revenue and cost structures. In OBC BMs, income is often decoupled from product usage or ownership, requiring pricing schemes like Pay-Per-Use (PPU) or Pay-Per-Output (PPO). These models demand reliable digital infrastructure for tracking performance and robust systems for outcome verification (Visnjic et al., 2016; Kohtamäki et al., 2020). Because providers assume greater responsibility for customer results, the design phase must also address risk redistribution. Investments in predictive maintenance, real-time analytics, and data-driven decision-making become essential to mitigate risks and ensure reliable service delivery (Ng & Nudurupati, 2010; Benedettini et al., 2015).

Another important focus area is the redefinition of customer relationships. OBC BMs involve long-term, performance-linked partnerships that require trust, transparency, and shared goals. During the design phase, companies must establish governance mechanisms and joint monitoring systems that foster collaboration. Additionally, as few companies can deliver complex outcomes alone, integrating ecosystem partners—such as technology providers and service subcontractors—is critical. Their roles must be clearly defined within the delivery architecture to ensure accountability and smooth coordination (Kohtamäki et al., 2019; Adrodegari & Saccani, 2017).

Risk management is another critical output of a robust design process. Outcome-based models expose providers to various financial, operational, and reputational risks. Systematic business model design enables companies to identify these risks early and implement mitigation strategies, such as performance guarantees,

flexible contracts, and contingency plans. Piloting the model in low-risk settings, particularly beneficial for SMEs, helps test assumptions, refine performance metrics, and identify operational gaps before broader implementation (Antikainen & Valkokari, 2016).

Equally important is the internal alignment of the company. Transitioning to outcome-based logic often requires new organizational structures, incentive systems, and capabilities. Sales and service teams may need retraining, while data systems must be reoriented toward performance monitoring and continuous improvement. The design phase must therefore ensure that the company's internal operations and culture are prepared to support the new model effectively (Parida et al., 2014; Gebauer et al., 2021).

For SMEs, adopting OBC BMs through BMI offers a path to competitive differentiation, more stable revenue through service-based income, and increased operational efficiency. It also encourages digital capability development and more resilient business practices. For larger companies, BMI enables the deployment of scalable service systems, integration of advanced analytics, and management of complex delivery networks, all while fostering stronger customer lock-in and promoting environmental sustainability (Tukker, 2015; Visnjic et al., 2016).

In both cases, the design phase of BMI supports the shift from product-based to outcome-based models by embedding customer-centric thinking, data-driven operations, and flexible service architectures. It ensures that the business model is not just a contractual arrangement but a coherent, strategically aligned transformation. (Sjödin et al., 2020)

Finally, systematic business model design and innovation play a pivotal role in maximizing the benefits and minimizing the risks of OBC BMs. A structured design process allows companies to develop clear, measurable value propositions, optimized revenue mechanisms, and robust operational systems. It supports technological integration, customer engagement, and risk mitigation through early testing and feedback loops. It also enables companies to define roles and responsibilities within their ecosystems and embed contractual safeguards to handle uncertainties in outcome delivery. Sjödin et al. (2020) emphasize that a structured, multi-phase approach to business model innovation is crucial for the successful implementation of outcome-based business models (OBC BMs). Their framework, comprising value proposition definition, value provision design, and value-in-use delivery, illustrates how companies can reduce implementation risks and ensure operational and technological fit by establishing clear performance metrics, engaging customers iteratively, and aligning internal functions. This process-driven approach enables companies to systematically develop capabilities, define stakeholder roles, and embed performance accountability across the business model. This structured innovation logic directly supports the central argument of this dissertation: that the successful adoption of OBC BMs requires more than the deployment of enabling technologies, it also demands a deliberate, iterative, and well-aligned design process. This is especially pertinent in the SME context, where companies face resource limitations but benefit from organizational agility and close customer relationships. By following a systematic approach, SMEs can better manage the complexity of OBC BM implementation and enhance their ability to create, deliver, and capture value under outcome-based logic.

In summary, the design phase is not merely preparatory but can be also foundational to the success of OBC BMs. It aligns strategy with execution, strengthens internal capabilities, and lays the groundwork for delivering sustainable, outcome-focused value to customers. By taking a systematic approach to business model design and innovation, companies can unlock new growth opportunities while reducing exposure to the operational, financial, and strategic risks that come with outcome-based transformation.

3 RESEARCH METHODOLOGY

This dissertation adopts a structured and systematic approach to investigating the design, utilization, and benefits of OBC BMs for MMs. The research design is directly guided by the two research questions: RQ1, which examines how OBC BMs create opportunities and risks for manufacturing firms, and RQ2, which explores how these opportunities and risks differ between SMEs and large companies. To ensure methodological rigor, the study follows Saunders et al.'s (2019) Research Onion framework, which provides a structured basis for defining the research philosophy, strategy, methods, and techniques for data collection and analysis. This framework enables the selection of approaches that are appropriate for capturing both the general mechanisms of OBC BMs (addressing RQ1) and the firm-size-specific dynamics of their implementation (addressing RQ2).

Research Philosophy

The research philosophy underpins the fundamental assumptions about how knowledge is generated and how it informs the methodological choices guiding this dissertation. This study adopts an interpretivist philosophy, as it seeks to explore the complex and socially constructed nature of outcome-based business models (OBC BMs) in the machine manufacturing (MM) industry from the perspectives of industry practitioners. The interpretivist stance aligns with a qualitative, context-dependent exploration of organizational phenomena, emphasizing multiple realities and meaning-making rather than universal generalizations (Creswell & Creswell, 2018; Easterby-Smith et al., 2021). Given that OBC BM implementation is shaped by strategic decisions, organizational capabilities, and industry-specific constraints, an interpretivist approach provides the necessary depth and flexibility to capture the subjective meanings and lived experiences of key stakeholders (Saunders et al., 2019). This philosophical orientation supports a rich understanding of how practitioners interpret, enact, and evolve outcome-based business models within their operational contexts.

Interpretivism is based on the belief that reality is socially constructed and that knowledge is developed through interactions, experiences, and contextual understanding, rather than through universal, objective laws (Denzin & Lincoln, 2011). This approach is particularly relevant for business model research, where companies operate in diverse environments and make strategic choices based on industry-specific conditions, resource availability, and customer relationships (Eisenhardt & Graebner, 2007).

Unlike positivism, which relies on quantitative data, statistical analysis, and hypothesis testing, interpretivism embraces qualitative research methods to gain deeper insights into strategic reasoning, motivations, and implementation challenges (Bryman & Bell, 2011). By focusing on case studies, interviews, and literature reviews, this dissertation seeks to explore and interpret how different companies design, implement, and scale OBC BMs.

Since relatively little research exists on Research Questions 1 and 2, particularly from the perspectives of SMEs and outcome-based service providers, and given the relatively recent adoption of OBC BMs by SMEs, it is essential to study their application by exploring how these companies have addressed emerging challenges in practice. An interpretivist approach is therefore adopted to examine the phenomenon in a contextualized and

nuanced manner. SMEs and large manufacturers often face distinct challenges and opportunities: while SMEs tend to prioritize flexibility, adaptability, and close customer relationships, large companies are typically more focused on scalability, digital integration, and cost-efficiency. Capturing these differences through qualitative methods ensures that the findings are grounded in practical business realities, rather than abstract or overly generalized assumptions.

A Subjective and Contextual Reality from ontology point of view

Ontology concerns the nature of reality and how it is perceived. This dissertation adopts a subjectivist ontological stance, recognizing that OBC BM adoption and design are shaped by company-specific factors, competitive dynamics, and managerial interpretations. There is no single, objective reality regarding how OBC BMs should be designed or implemented. Instead, companies interpret and adapt these models in ways that align with their unique resources, competitive positioning, and market environment (Teece, 2010). For example: SMEs may emphasize personalized service models and customer engagement as critical success factors in OBC BMs or large manufacturers may prioritize data-driven scalability, automation, and integration into global supply chains. These company-specific variations highlight the need for qualitative inquiry to understand how stakeholders construct and interpret their business model realities.

The dissertation from epistemology point of view

From epistemology point of view this dissertation conducts knowledge through subjective interpretation. Epistemology concerns how knowledge is acquired and validated. This dissertation follows an interpretivist epistemology, recognizing that knowledge is co-constructed through human interactions, practitioner insights, and contextual analysis, rather than being discovered through purely objective observation (Saunders et al., 2019).

By engaging directly with industry practitioners, including business executives, engineers, and strategists, this dissertation captures their lived experiences, decision-making processes, and strategic reasoning in adopting OBC BMs. The qualitative methods employed, interviews, case studies, and literature synthesis, enable an exploratory and iterative investigation of topics that remain under-researched, particularly from the perspectives of SMEs and outcome-based service providers. Rather than testing predefined theories, the dissertation allows insights to emerge organically from real-world business practices, ensuring relevance to the unique challenges and opportunities faced by these companies.

This epistemological stance aligns with the dissertation's inductive research approach, in which patterns and themes are derived from empirical findings, rather than testing a universal theory (Gioia, Corley, & Hamilton, 2013). Since companies in different contexts may interpret and implement OBC BMs differently, capturing these insights through qualitative methods ensures practical relevance and theoretical depth.

The interpretivist research philosophy directly shapes the methodological choices in this dissertation. Given the exploratory nature of OBC BM adoption, the dissertation relies on qualitative methods, including:

- Qualitative Case Studies: Examining OBC BM adoption across multiple companies allows for a comparative understanding of strategic decision-making (Yin, 2018). Case studies provide rich,

context-specific insights into business model evolution, key challenges, and company-specific adaptations.

- In-Depth Interviews: Conducting interviews with business executives, decision-makers, and operational managers provides firsthand insights into OBC BM implementation, strategic motivations, and risk perceptions (Eisenhardt & Graebner, 2007). Unlike surveys, which impose fixed response categories, interviews allow free expression of perspectives, revealing deeper strategic reasoning.

- Literature Review: Reviewing academic and industry sources helps to identify theoretical gaps and contextualize findings within broader business model innovation discourse (Snyder, 2019).

These methods ensure that the dissertation remains flexible and adaptive, allowing for an iterative exploration of emerging themes in OBC BM adoption.

Why interpretivism over other philosophical approaches? A positivist approach would have emphasized objective measurement, statistical analysis, and hypothesis testing, based on the assumption that generalizable laws govern the adoption of Outcome-Based Business Models (OBC BMs) (Saunders et al., 2019). While valuable for quantifying company performance or customer behavior, such an approach falls short in capturing the deeper strategic reasoning, managerial perceptions, and organizational barriers involved in OBC BM implementation. In particular, it would not adequately address the nuanced understanding required to explore the design, risks, and benefits of OBCs—especially from the under-researched perspectives of SMEs and companies in the machine manufacturing (MM) sector. An interpretivist perspective, by contrast, allows for a rich, context-sensitive exploration of these complex and evolving business practices. Since OBC BMs are highly contextual and evolve differently across companies, a purely positivist lens would fail to capture the nuances and complexities explored in this dissertation.

A pragmatist approach, which combines qualitative and quantitative methods, could have been an alternative (Tashakkori & Teddlie, 2010). However, since this dissertation primarily seeks to explore how companies interpret, design and implement OBC BMs rather than measure their financial impact, an exclusively qualitative, interpretivist approach is more appropriate.

As a conclusion this dissertation adopts an interpretivist research philosophy, emphasizing subjective experiences, strategic decision-making, and the contextual nature of OBC BM adoption in the machine manufacturing industry. By prioritizing qualitative insights over rigid, objective measurements, the dissertation captures the real-world complexities of business model innovation in SMEs, and partially also large manufacturers from some novel perspectives.

Through an ontological stance that views reality as socially constructed and context-dependent, and an epistemological stance that acknowledges knowledge as co-created through practitioner insights, this dissertation ensures that its findings are both academically rigorous and practically meaningful.

By employing qualitative case studies, interviews, and literature synthesis, the dissertation remains exploratory and inductive, uncovering emerging patterns rather than testing predefined hypotheses. This methodological choice allows for a deep, contextually rich exploration of how OBC BMs are designed, adopted, and adapted

within different organizational settings. This dissertation philosophy enables that the dissertation provides a nuanced, practitioner-informed perspective on OBC BMs, contributing valuable insights to both academic discourse and industry practice.

This dissertation explores how enterprises, especially SMEs in machine manufacturing can adopt OBC BMs in the context of modern digital servitization and Industry 4.0. A review of the existing literature revealed that while OBC BMs have been widely studied in large companies and capital-intensive sectors, there is a clear lack of empirical research addressing how resource-constrained SMEs implement and benefit from such models. This gap led to the formulation of research questions focusing on the opportunities, risks, growth mechanisms, and design practices associated with OBCs in SME settings. Using a qualitative, multiple-case study methodology across four publications, the dissertation investigates real-world implementations of Pay-Per-Output (PPO) and Pay-Per-X (PPX) models (Publications I & II), proposes a conceptual design framework for OBC BMs and develops a morphological configuration model grounded in empirical data (Publication III), and examines the challenges, benefits, and mitigation strategies specific to SMEs (Publication IV). Together, these studies contribute to academic knowledge by extending OBC BMs and business model innovation frameworks to include SME-specific pathways, digital integration, and configurational design logic. The findings also offer practical tools and actionable insights for manufacturers seeking to shift from product-based sales to value- and performance-based offerings, contributing to both scholarly understanding and industrial transformation.

3.1 Research questions, research strategy and research choices

Research questions' structure

This dissertation explores the adoption and design of OBC BMs in the MM sector, with a particular focus on small and medium-sized enterprises (SMEs). While OBC BMs are increasingly discussed in the context of digital servitization, most existing research focuses on large companies, leaving a gap in understanding how SMEs, with limited resources and different operating conditions, can execute such transitions. To address this, the dissertation is structured around two interlinked research questions. The first question investigates the strategic opportunities and risks associated with OBC adoption in both SMEs and large companies, establishing a broad understanding of benefits, barriers, and enabling factors. The second question builds on this by examining how OBC business models can be effectively designed and configured, particularly under SME-specific constraints. Together, the questions move from understanding why companies adopt OBC BMs to how they can implement them in practice, forming a coherent framework for the four interrelated publications that compose this dissertation.

RQ1: What Kind of Opportunities (Benefits and Risks) Do OBC BMs Offer for Machine Manufacturers?

The first research question investigates the potential benefits and risks associated with OBC BMs for both SMEs and large manufacturing companies. To explore this, the dissertation primarily adopts a deductive approach, particularly in Publication III, which synthesizes existing literature to establish a theoretical foundation. This publication identifies key characteristics required for OBC BM adoption and uses them to analyze the implications for companies of different sizes. The theoretical framework developed from prior research provides a structured basis for systematically comparing how SMEs and large manufacturers may benefit from, or be challenged by, the adoption of OBC BMs.

However, given that OBC BMs represent an evolving and context-specific business model within the machine manufacturing sector, a solely deductive approach is insufficient. Therefore, all Publications adopt an inductive approach, generating insights directly from empirical data collected in real-world industrial contexts.

Publications I and II focus specifically on SMEs, examining how OBC BMs influence sales growth and profitability. These studies identify concrete opportunities, such as access to new revenue streams through service-based models, as well as risks like financial uncertainty and customer dependency. Rather than testing pre-existing theories, these investigations uncover new mechanisms linking OBC BMs to business performance, insights that emerge organically from empirical observations, consistent with inductive reasoning.

Publications III and IV adopt a broader perspective, encompassing both SMEs and large manufacturers. Using qualitative surveys and in-depth interviews with industry practitioners, these studies explore the lived experiences of companies engaging with OBC BMs. This approach enables the identification of both expected and unforeseen outcomes. While SMEs often face challenges related to financing and operational transformation, large companies struggle with issues of scalability and long-term service delivery. These publications remain open to emerging patterns, allowing themes to surface from the data rather than being constrained by theoretical assumptions.

Overall, the dissertation's investigation of Research Question 1 follows a deductive-to-inductive trajectory: it begins with a literature-based theoretical framework and then refines and expands this understanding through empirical evidence. This combined approach ensures that findings are both theoretically informed and practically grounded, offering insights relevant to organizations of varying sizes.

Despite increasing interest in OBC BMs within manufacturing, there remains a limited understanding of their practical implementation and strategic impact, particularly in the MM sector. Existing literature has largely focused on general benefits and conceptual aspects of OBC BMs, often overlooking how these models affect companies of different sizes. Specifically, small and medium-sized enterprises (SMEs) have received insufficient attention, despite their distinct capabilities, constraints, and strategic needs compared to large companies.

This dissertation addresses that gap by examining how OBC BMs create opportunities and risks for both SMEs and large MMs. Publications I and II contribute new knowledge by identifying mechanisms for sales growth and analyzing profitability impacts in SMEs.

Publications III and IV respond to this need through qualitative research, refining the initial framework and capturing company-level insights into challenges, benefits, and design processes. Additionally, these studies highlight a lack of guidance on how to systematically design OBC BMs, especially tailored to the needs of SMEs. Thus, the dissertation fills a dual gap: the underexplored impact of OBC BMs on SMEs, and the limited understanding of how such models can be effectively designed and operationalized in the MM context.

RQ2: How Can MMs Design OBC BMs?

The second research question shifts from adoption to design, focusing on how both SMEs and large manufacturers can structure OBC BMs effectively. Given that OBC BM design remains an evolving area with limited established theoretical models, this question requires a combination of deductive and inductive approaches to accommodate different company sizes.

A deductive approach is applied in Publication III, which develops a conceptual framework consisting of 16 critical characteristics necessary for OBC BM implementation. This framework is derived from existing academic knowledge, ensuring that the dissertation follows a structured, theory-driven approach. This model provides an initial blueprint for both SMEs and large companies but does not yet incorporate industry-driven variations. To bridge the gap between theoretical models and real-world implementation, an inductive approach is employed in Publications III and IV, where qualitative surveys and interviews allow researchers to refine the framework based on empirical findings.

In addition, the Publication III gathers qualitative survey data from MMs of various sizes, helping to validate and adapt the conceptual framework. SMEs often emphasize cost management, adaptability, and flexibility, while larger companies focus on long-term scalability, digital integration, and global market expansion. Instead of simply applying the theoretical model, this dissertation allows respondents to shape and refine the framework, making it practically relevant for different types of companies. Publication IV takes the inductive process further by investigating real-world challenges faced by both SMEs and large manufacturers in OBC BM implementation. SMEs struggle with resource constraints and risk management, while large companies need to align OBC BMs with complex, pre-existing operational structures. Instead of testing predefined hypotheses, this dissertation lets industry participants define key challenges and best practices through in-depth interviews, leading to the discovery of new, size-specific considerations.

Thus, the investigation of RQ2 follows a deductive-to-inductive process: it begins with a theoretical model (deductive) and refines it using empirical industry feedback (inductive), ensuring that the final framework is applicable to both SMEs and large manufacturers.

To ensure that the dissertation adequately accounts for the differences between SMEs and large manufacturers, it strategically integrates deductive and inductive reasoning. Deductive reasoning is used where prior knowledge

exists, such as in the conceptual framework development (Publication III). This ensures a structured foundation applicable to different company sizes. Inductive reasoning is employed when empirical data is needed to refine or expand existing theories, such as in qualitative surveys and interviews (Publications III & IV). These methods ensure that findings reflect the real-world experiences of SMEs and large companies alike.

This methodological integration bridges the gap between theory and practice while ensuring size-specific relevance. The deductive approach ensures academic depth, while the inductive approach guarantees empirical relevance. Ultimately, this dual approach validates existing knowledge while uncovering new insights, making the dissertation both explanatory and exploratory, with clear distinctions between the challenges and opportunities faced by SMEs versus large companies in adopting and designing OBC BMs.

Reasoning Logic and Research Phases

In alignment with the interpretivist philosophy underpinning this dissertation, the reasoning logic follows a qualitative, iterative, and context-sensitive approach aimed at understanding the dynamic adoption and design of OBC BMs in the MM sector. Given the exploratory nature of the research questions, addressing both why and how OBC BMs are adopted (RQ1) and designed (RQ2), the study primarily applies inductive and mixed reasoning logics. This combination enables the development of theoretical understanding grounded in empirical evidence while allowing iterative movement between data and theory (Dubois & Gadde, 2002; Saunders et al., 2019; Gioia et al., 2013; Gillespie et al., 2024).

The research strategy acknowledges that complex socio-technical phenomena, such as OBC BM implementation, cannot be fully captured through a single reasoning mode. This iterative approach ensures that both empirical and theoretical insights evolve dynamically throughout the research process. Mixed reasoning logic allowed the study to move beyond descriptive understanding toward theoretical refinement, where emergent insights reshaped existing conceptual frameworks in light of practical findings.

Building on this reasoning structure, the dissertation contributes to extending and refining the theoretical foundations established by Lay et al. (2009) and Hypko at al. (2010). Lay et al. (2009) provided a typology of service-based business concepts in B2B markets, distinguishing models according to their degree of integration between product and service elements. Hypko et al. (2010) further advanced this understanding by clarifying the logic of performance-based contracting and differentiating it from other servitization-related models. The findings of this dissertation expand these frameworks by incorporating the digitalization and data-driven mechanisms that increasingly define how value, risk, and performance are configured in industrial settings.

Furthermore, following Gillespie et al. (2024), the study views research question formulation as an evolving process of inquiry, where questions are refined through iterative cycles of theorizing and empirical exploration. This reflexive stance reinforces the study's mixed reasoning approach, which integrates both inductive insights from empirical observations and deductive logic derived from existing theory. In doing so, the theoretical framework is allowed to emerge and mature alongside the research process rather than being predetermined at its outset.

In qualitative business research, inductive reasoning involves building theory from empirical observations, where patterns and themes emerge directly from data without predefined hypotheses. In contrast, deductive

reasoning begins with established theories or conceptual frameworks, which are then tested or refined through empirical investigation (Saunders, Lewis, & Thornhill, 2019). Induction is thus primarily exploratory, while deduction is confirmatory—yet in complex organizational and socio-technical contexts, relying exclusively on either logic can limit both theoretical and practical relevance (Blaikie, 2010).

Mixed reasoning logic bridges these two approaches by integrating inductive and deductive elements in a complementary and iterative manner. Rather than progressing linearly from theory to data (deduction) or from data to theory (induction), mixed reasoning involves a continuous interplay between conceptual understanding and empirical evidence (Dubois & Gadde, 2002; Ketokivi & Choi, 2014). This approach allows theoretical models to guide data collection and, in turn, enables empirical findings to reshape and extend theory. Mixed reasoning is particularly valuable in exploratory and evolving fields, such as outcome-based business models, where partial theoretical foundations exist but require empirical grounding and contextual adaptation. It aligns closely with the abductive tradition, emphasizing systematic combining of theory and practice to generate robust, plausible, and contextually relevant insights (Dubois & Gadde, 2002; Saunders et al., 2019). Table 3. presents the reasoning logics applied in each phase of the dissertation, showing how inductive and mixed reasoning approaches were used to address different research objectives. The inductive logic guided the early exploratory phases, allowing theoretical insights to emerge directly from empirical observations, while the mixed reasoning approach integrated theory-driven and data-driven insights in later stages to refine and validate the conceptual framework.

Table 3. presents an overview of the data collection and analysis techniques applied across the four publications, showing how each methodological phase contributes to addressing the overarching research questions. The table illustrates a progressive research design, where the studies build sequentially on one another to deepen theoretical understanding and empirical validation of OBC BMs in manufacturing SMEs. The first two publications adopt an inductive reasoning approach through multiple case studies and semi-structured interviews, allowing insights to emerge directly from empirical data. These phases focus on identifying the key advantages, hindrances, and mechanisms influencing the implementation and performance of pay-per-output and performance-based business models. The third phase integrates mixed reasoning, combining inductive insights from expert interviews with deductive logic derived from existing theory. This stage bridges empirical findings and theoretical development by refining the conceptual understanding of OBC adoption challenges and enablers. Finally, the fourth phase returns to an inductive logic within a qualitative case study, where the previously developed conceptual framework is empirically validated through its application in a real SME context.

Overall, the table reflects an iterative and cumulative research process, where each phase addresses specific research questions that collectively advance the study's overall objectives. Early phases (Papers 1 and 2) primarily answer exploratory RQ1 related to "what", uncovering phenomena and mechanisms behind OBC adoption (benefits and risks). The later phases (Papers 3 and 4) move toward explanatory and evaluative questions, examining "how" and "under what conditions" the conceptual framework is applicable and useful by answering RQ2; "How MMs can design OBC BMs. The evolution of reasoning logics across phases from inductive to mixed reasoning and back to inductive, mirrors the study's reflexive approach, where theory is continuously refined through the interplay of empirical evidence and conceptual development.

Table 4. Reasoning logic and phases of dissertation.

Phase	Publications	Reasoning Logic	Purpose	Activitity
1. Phenomenon identification and initial understanding	Pub I–II	Inductive	To explore and describe the phenomenon (OBC/PPX models in SMEs), including benefits and risks.	Empirical case studies → reduction of observations and identification of themes.
2. Development and preliminary validation of the conceptual model	Pub III	Mixed reasoning	To iteratively move between theory and empirical data to generate explanatory insights.	Integration of theory and interview data → morphological analysis.
3. Model refinement and validation	Pub IV	Inductive	To refine and validate the conceptual model using new empirical material.	SME interviews → verification of risks, benefits, and design processes.

3.2 Data sources, collection and analyses

This dissertation employs a mixed-methods research design following Saunders' 'Research Onion' framework, integrating qualitative and secondary data sources to ensure a comprehensive examination of OBC BM adoption in MM SMEs and large companies. The research strategy combines qualitative semi-structured interviews, systematic literature reviews, and case study analyses to provide both exploratory and explanatory insights. This methodological approach is directly aligned with the research questions (RQs) guiding the dissertation. Specifically:

- RQ1: Investigating the mechanisms and challenges of OBC BM adoption in MM SMEs and large companies is addressed through qualitative semi-structured interviews and case study analyses. These methods capture industry professionals' insights, providing empirical evidence of business model implementation and strategic decision-making.

- RQ2: Exploring the factors influencing the design and operationalization of OBC BMs is supported by systematic literature reviews and comparative case study analysis. The literature review synthesizes theoretical foundations and DC, while cross-case comparisons highlight industry-specific variations and strategic motivations.

Table 5. Data collection and analysis techniques for each publication and RQs.

Methodology	Multiple case study	Multiple case study	Literature review and multible case study	Qualitative case study
Methods	Qualitative semi-structured interviews	Qualitative semi-structured interviews	Qualitative survey and qualitative structured/semi-structured interviews	Qualitative survey and qualitative semi-structured interviews
Reasoning approach for analysis	Inductive	Inductive	Mixed reasoning	Inductive
Data	Systematic Presentation of Advantages and hindrances for implementation of pay-per-output (PPO) business model (BM) for SME size capital goods manufacturing companies.	New, identified Mechanisms for rapid sales growth by implementation of PPX business models and PPX implementation impact to the profitability in investment product manufacturing SMEs.	Introduction of the new empirical data derived from expert interviews with SMEs in the machine manufacturing sector. These insights provide a practical perspective on the challenges, enablers, and organizational requirements for adopting OBC BM.	Presentation of the refined conceptual framework for OBC BM adoption, validated through application in a real SME case study. The case demonstrates how the framework can guide strategic decision-making, identify capability gaps, and structure the transition toward an OBC model.
Duration of the interview	App. 2 hours	App. 2 hours	App. 1,5 hours	App. 1,5 hours
Interviewed persons	R&D Managers / SME executives	R&D Managers / SME executives	Directors, founder/CEO	Directors, founder/CEO

A combination of qualitative interviews and case study research was applied across multiple publications to capture the perspectives of industry professionals involved in business model adoption and technological transformation. Publications I and II utilized qualitative interviews with R&D managers and senior executives from SMEs implementing OBC BMs. These interviews, lasting approximately two hours, followed a semi-structured format to extract insights on strategic objectives, profitability impact, and challenges in adoption. Similarly, Publication IV employed a qualitative case study approach, using interviews, ThinkTank responses, and company reports to explore SME and large company decision-making in OBC BM design, operations, and asset ownership.

A systematic literature review results was employed in Publication III to synthesize existing academic discourse and identify key theoretical frameworks relevant to OBC BM adoption. In this publication morphological analysis helps by identifying key parameters such as pricing models, service agreements, risk-sharing mechanisms, and customer value propositions, exploring different combinations (e.g., fixed fee vs. performance-based pricing) to assess their feasibility and developing strategic variations tailored to industry needs.

The analysis further employed coding techniques to categorize key factors such as contract structures, financial risk distribution, and strategic motivations for transitioning to OBC BMls. Additionally, a comparative synthesis was performed to identify patterns in adoption across different industrial company sizes and ensure a broad understanding of contextual variables influencing decision-making.

To ensure empirical validation, case study research was integrated into Publications I, II, III, and IV, allowing wider exploration of OBC BMs in MM. Case selection followed theoretical sampling criteria, ensuring relevance to OBC BMs implementation and design. Data was collected from interviews, company reports, and

industry documentation, facilitating cross-case comparisons to identify strategic variations across companies. In Publication III, a multi-phase methodology combined systematic literature review, expert evaluation, and case study analysis, ensuring a specific examination of DC for OBC BMs in MMs.

The data analysis methods varied according to the research approach (Creswell&Creswell, 2018). Qualitative interview data were manually coded and analyzed thematically to identify recurring patterns. Recurring patterns identified in the data analysis include key drivers of OBC BM adoption (e.g., cost efficiency, risk-sharing), common challenges (e.g., financial risks, contractual complexities), and strategic DC (e.g., pricing structures, asset ownership). Industry-specific variations emerged through cross-case comparisons, highlighting differences in adoption strategies. Patterns also revealed the impact on profitability and growth, recurring theoretical constructs (e.g., BM design), and shared stakeholder perspectives on implementation challenges and benefits. These insights ensure a structured understanding of OBC BM adoption in MM SMEs and large companies. Systematic literature reviews categorized DC for business model adoption, while case study analyses utilized cross-case comparisons to highlight industry-specific variations.

By employing a structured combination of qualitative interviews, literature reviews, and case studies, this dissertation ensures a comprehensive and methodologically sound exploration of OBC BM implementation and design. The integration of diverse data sources, collection and analyzing methods strengthens the reliability of conclusions and enhances understanding of how MMs navigate OBC BMs in competitive MM markets.

4 OBJECTIVES AND FINDINGS OF THE INDIVIDUAL PUBLICATIONS

In this section, the contributions are discussed, including the summary of the results and conclusions derived from all four Publications. Additionally, the section elaborates on the managerial implications that were conducted from these findings.

The table 4 below summarizes the focus, new data or contributions, and key outcomes of the four research papers included in this dissertation. Together, they build a structured understanding of Outcome-Based Contracting (OBC) adoption in small and medium-sized enterprises (SMEs) within the machine manufacturing sector—from theoretical foundations to practical application.

Table 6. Overview of dissertation publications and their contributions.

Publication	Focus	Contribution	Purpose
I	Exploring how pioneering capital goods manufacturing SMEs implemented pay-per-output business models in conjunction with automation systems. It examines the interaction between business model innovation and technological change during the implementation process, and analyzes how SME size influenced this transformation.	Publication defines how capital goods manufacturing SMEs implement pay-per-output business models alongside automation systems.	Enrich existing knowhow by integrating organizational, technical, and contextual factors into a refined framework for PPO adoption in SMEs.
II	Investigate how PPX BMs enable rapid sales growth for investment product equipment manufacturing SMEs and examines how this growth influences overall profitability. The research provides insights into the strategic and financial implications of PPX BMs.	Highlights how PPX BMs can drive rapid sales growth, while also uncovering the financial trade-offs and structural shifts required to maintain and improve profitability.	To understand how PPX BMs contribute to rapid sales growth in investment product equipment manufacturing SMEs, and to evaluate how this growth affects their overall profitability.
III	Initial Conceptual Framework Development and Framework Validation through Case Application	Integration of literature insights and theoretical models. Expert interviews with practitioners in machine manufacturing	Refines the conceptual framework; highlights practical enablers, barriers, and required capabilities. Validates framework's practical relevance; supports strategic planning and identifies implementation gaps.
IV	Empirical Insights on OBC Adoption in SMEs	Application of the refined framework in a real-life SME case study	Identifies research gaps; establishes foundations for OBC BM adoption in SMEs. Proposes an initial conceptual framework for OBC BM adoption in SMEs

4.1 Publication I

Implementation of pay-per-output business models and advanced automation systems in capital goods manufacturing SMEs

Publication I objectives

Although PPU and PPO business models have been examined in software companies and consumer goods contexts, their use and research remain rare in the capital goods manufacturing sector, particularly from the perspective of SMEs, where academic research is virtually nonexistent. To the best of my knowledge, this dissertation was the first to delve into the impact of SME company size on the adoption of these advanced business models and automation systems (AS) in capital goods manufacturing. Additionally, it explored the interaction between business models and AS in the context of pay-per-output non-ownership business models.

Paper 1 addressed the following research questions, with RQ3 being the most significant for the overall dissertation. RQ1: How were the pay-per-output business models and automation systems implemented in the studied pioneering capital goods manufacturing SMEs? RQ2: How did the business model and the automation system interact during the implementation process? RQ3: How did SME size influence the implementation process?

Publication I findings

Regarding RQ1, the adoption of PPX models led to rapid sales growth for the studied SMEs. While short-term profitability was not shown to be boosted, long-term profitability was positively impacted as the cost of the machines was amortized and additional profits were generated based on usage or output. Rapid sales growth was found to be driven by four key mechanisms identified from interview data: strategic, pricing, financing, and risk management mechanisms. Our findings show that regarding rapid sales growth, gaining new customers and expanding business with current ones were crucial for overall growth. The pricing mechanism was found to balance sales growth and profitability. Partnering with financial institutions was vital for rapid sales growth due to securing financial resources, and the PPU BM was influenced by risks related to sales growth and profitability. The results also highlighted that financing was crucial for implementing the OBC BM to achieve growth, and the companies interviewed emphasized the importance of risk management throughout this process.

SME-specific challenges and opportunities were identified. The size of the SMEs played a dual role: on one hand, their small size allowed for quick decision-making and the flexibility to offer customized solutions; on the other hand, it posed challenges in financing the equipment for OBC BMs. Third-party engagements, such as financial partners or distributors, were crucial in overcoming these challenges.

PPX models significantly boosted sales for investment product manufacturing SMEs by reducing purchasing thresholds through usage-based payment options. Various mechanisms, including pricing strategies and risk management, contributed to this growth.

The flexibility in pricing mechanisms under OBC BM enabled easier access to customers. Moreover, partnering with financial institutions for financing OBC BMs emerged as an essential strategy for SMEs to manage the high upfront costs associated with manufacturing complex machines.

4.2 Publication II

Rapid sales growth mechanisms and profitability for investment product manufacturing SMEs through pay-per-X business models

Publication II objectives

The primary objective of paper 2 was to investigate the utilization of OBC BMs by MMs (company A and B), particularly small and medium-sized enterprises (SMEs), within capital product markets, and particularly the rapid sales growth and profitability-related potential related to PPX business models in such SMEs. To our knowledge there is not much research to analyze the rapid growth of sales and profitability and related growth mechanisms through OBC BM in SME capital product manufactures. In this Publication, we initially used the term "PPX business model," but throughout the dissertation, I decided to use the term "OBC BM" as it more comprehensively describes business models that refer to output or outcome.

We formulated the following research questions: RQ1: How is the rapid sales growth achieved by OBC BM s for investment product equipment manufacturing SMEs? RQ2: How does the rapid sales growth enabled by OBC BMs impact overall profitability for investment product equipment manufacturing SMEs? Both of these RQ's are relevant from the respective of the whole dissertation.

Recent studies have examined emerging topics such as novel IIoT-supported or enabled services and advanced non-ownership business models, including pay-per-use (PPU) and pay-per-performance (PPO) models. However, these studies have seldom explored the perspective of capital goods manufacturing companies or SMEs and have offered limited managerial insights to such entities. (e.g. Gebauer et. al. 2017)

Overall, there is limited research focusing on comprehending the role of OBC BM, within companies operating in the investment product sector. These companies exhibit significant differences from those analyzed in much explored OBC BM services and business models, e.g., within the much more widely studied software sector, as well as the relatively more researched OBC BMs in the mass consumer product sector. Notably, the latter (OBC BMs in software and mass consumer product industries) vary markedly from investment products in aspects such as the utilization of economies of scale in their OBC BMs. Additionally, this Publication emphasizes the substantial variance in supplier risk profiles between investment/make-to-order products and other sectors.

Publication II findings

Regarding RQ1, the adoption of OBC BMs led to rapid sales growth for the studied SMEs. While short-term profitability did not show significant improvement, long-term profitability was positively impacted as machine costs were amortized over time and additional profits were generated based on usage or output.

Four key mechanisms were identified from interview data as drivers of rapid sales growth: strategic, pricing, financing, and risk management. Gaining new customers and expanding business with existing ones emerged as crucial factors for growth. The pricing mechanism played a central role in balancing sales growth with profitability. Partnering with financial institutions proved vital, as it helped secure the necessary resources for scaling under the OBC BM. Additionally, risks related to sales growth and profitability significantly influenced

the Pay-Per-Use (PPU) business model. Financing was essential for implementing OBC BM, and interviewees emphasized the importance of effective risk management throughout the process.

SME-specific challenges and opportunities were also identified. The small size of SMEs acted as a double-edged sword: on one hand, it allowed for quick decision-making and the flexibility to offer tailored solutions; on the other, it posed challenges in financing the equipment required for OBC BMs. Third-party involvement, such as financial institutions or distributors, was essential in overcoming these constraints.

PPU models significantly boosted sales for investment product manufacturing SMEs by lowering purchasing thresholds through usage-based payment options. Mechanisms such as pricing strategies and risk management further contributed to this growth.

Regarding RQ2, Publication II provided valuable insights into how SMEs in the investment product manufacturing sector can use OBC BMs to enhance sales and improve long-term profitability. The findings highlighted the importance of strategic planning; particularly in pricing, financing, and risk management; for effective implementation. The dual nature of SME size was evident: while agility was an advantage, resource limitations presented challenges.

There was a clear link between rapid sales growth and overall profitability, though outcomes varied among companies. The OBC BM supported margin growth by shifting the focus from the highly competitive hardware market to a more service-oriented OBC BM market. Although third-party involvement initially affected profitability, it ultimately contributed to stronger sales growth.

OBC models offered strategic benefits by significantly lowering the purchase threshold for customers, making it easier to target new segments that previously found upfront investment costs prohibitive. Flexible, usage-based pricing allowed companies to better meet customer needs and facilitated access to previously unreachable markets. Partnerships with financial institutions were essential for managing the high upfront costs of manufacturing complex machinery.

Overall, the implementation of the PPU business model and automation systems in these SMEs revealed several unexpected insights. A notable challenge was the significant customer skepticism both companies encountered, even though the PPU model reduced financial risk by linking payments to output. This resistance, especially in less familiar markets, underscored the difficulty of shifting customer mindsets, despite clear benefits.

Another surprising aspect of Company A's strategy was its focus on optimizing competitors' machines. By offering cross-brand optimization services, the company expanded its market and established a unique niche. Both companies leveraged their small, flat organizational structures to gain deep customer insights through direct communication, offering a cost-effective alternative to traditional market research and giving SMEs an edge over larger companies.

Interestingly, limited resources also proved advantageous. Resource constraints forced companies to focus on essential activities, leading to more efficient implementation and faster decision-making. This agility stands in contrast to the "analysis paralysis" often seen in larger organizations. Finally, Company B's use of the PPU model for high-cost machinery was particularly notable, as it allowed customers to access expensive equipment without upfront investment, further expanding its market reach. These insights illustrate how SMEs can

leverage their unique structures, resource limitations, and innovative business models to drive growth and differentiate themselves in competitive markets.

4.3 Publication III

Morphological Analysis for Designing and Configuring Outcome-based Contracts for Machine Manufacturers: An Empirically Grounded Conceptualization Designing Outcome-based Contracts for Machine Manufacturers: A Review and Proposal for Conceptual Model

Publication III objectives

The rise of OBC BMs, driven by Industry 4.0 technologies like IoT and data analytics, marks a major shift in manufacturing business models—from selling machines to delivering outcomes such as availability, performance, and cost savings. While OBC BMs promise increased revenues and closer customer relationships, they introduce complex challenges for MMs, particularly in the B2B sector, including asset ownership, risk-sharing, and operational responsibilities.

Despite growing interest, there is limited guidance on how MMs should design OBC BMs to manage lifecycle profits and risks. Publication III focuses on identifying the critical DC and configuration options essential for OBC BM design in machine manufacturing.
The Publication aims to answer two research questions:

- RQ1: What are the key DC for designing OBC BMs in machine manufacturing?
- RQ2: What are the main configuration options for these criteria?

Using a morphological analysis approach, the Publication draws insights from recent case studies and six empirical cases involving diverse MMs. Findings were refined with input from a multidisciplinary research team. The paper is structured to cover theory, methods, results, discussion, and conclusions with recommendations for future research.

Publication III findings

Publication III contributes new and significant insights to the field by addressing aspects of OBC BM that have been largely overlooked from the perspective of MMs. While previous studies have discussed OBCs conceptually, they often lack practical guidance for designing and configuring these models. Our Publication fills this gap by applying a comprehensive methodology that includes a systematic literature review, expert team evaluation, and empirical validation through six case studies with companies currently offering OBCs. Through this approach, we identified 22 additional DC, largely influenced by recent technological advancements such as Industry 4.0 and the Industrial Internet of Things (IIoT), which have opened new opportunities related to data ownership, remote access, and enhanced customer interaction.

One unique aspect of our research is the focus on non-moving machines, which have been underrepresented in existing OBC BM literature. These types of machines pose specific challenges, such as how to design OBCs that serve multiple customers over time. Our case companies, all recent adopters of OBC BMs, are still

navigating these long-term considerations, which adds a fresh perspective not previously captured in earlier studies.

Another key contribution is our detailed analysis of ownership-related DC. We introduced a more nuanced view by separating responsibilities for software, data, raw materials, and consumables. This distinction is important for managing intellectual property, ensuring confidentiality, and generating new revenue streams, for instance, through software subscriptions or material supply services. Our findings also contrast with earlier research suggesting joint ownership models; in practice, our case companies avoided these due to complications in international operations.

Additionally, we uncovered several new configuration options not previously addressed in the literature. These include third-party ownership of machines and varying machine utilization levels. In some cases, companies created separate entities or involved financing partners to own assets, reflecting a trend toward more flexible and shared-risk OBC BMs. Flexible machine utilization also allows MMs to better align production with fluctuating customer demand, improving service efficiency.

Finally, Publication III expands the sustainability dimension of OBC BMs by identifying mid- and end-of-life DC such as recycling, scrapping, and reselling. While earlier literature primarily focused on modernization, our research highlights how these additional criteria support circular economy practices and reduce reverse supply chain burdens. In summary, this research advances both theory and practice by presenting new DC, options, and insights relevant to the design and successful implementation of OBC BMs in the context of machine manufacturing.

4.4 Publication IV

Challenges, Mitigation and Benefits of Outcome-based Contracts in Small and Medium-sized Machine Manufacturers: A Qualitative Exploratory Study

Publication IV objectives

In Publication IV we explored deeper OBC BMs particularly in Small and Medium-sized Enterprises (SMEs), highlighting the challenges, mitigation strategies, and benefits of such contracts. This paper grounded in the analysis of four diverse companies illuminates how OBC BMs are instrumental in reshaping business strategies and operational models within SMEs.

Recent shifts in the business models of manufacturing companies have seen a transition from merely vending machinery to providing value through OBC BMs, where outcomes are quantified in terms of machine availability hours, units produced, or cost savings attributable to the OBC BM framework (Schaefers et al., 2021; Böhm et al., 2016; Grubic and Jennions, 2018; Korkeamäki et al., 2022; Neely and West, 2022; Shanmugam and Dhingra, 2023). This paradigm shift presents numerous advantages for these enterprises, including fostering supplier loyalty (Baines et al., 2007), expanding industry acumen and contributing to

environmental sustainability (Tukker, 2015). This Publication aims to explore the spectrum of challenges and opportunities that small to medium-sized enterprises (SMEs) and MMs encounter in the adoption and implementation of OBC BMs.

The current body of scientific research lacks comprehensive insights on the experiences of SME MMs in successfully implementing OBC BMs. While some studies (Zancul et al., 2016; Dahmani et al., 2020; Low et al., 2022) have explored SME MMs' approaches to maintenance, rental, and leasing agreements, and others have posited servitization as a strategic advantage for SMEs, detailed frameworks and models for servitization business strategies have been proposed (Kowalkowski et al., 2013; Adrodegari& Saccani, 2017; Kolagar et al., 2022). These models discuss necessary capabilities and technologies for SME MMs' servitization (Gebauer et al., 2012; Kanninen et al., 2017; Schroeder et al., 2020), yet they seldom address the specific challenges and advantages associated with OBCs for SME MMs. Only a single case within the literature (Adrodegari & Saccani, 2017) presents a SME MM's venture into product-service systems, highlighting challenges related to changing customer conditions, service personnel management, and cost estimation. The Publication suggests that these challenges can be mitigated by contract duration adjustments and penalties for contract condition changes, while also noting the benefits of OBCs in predicting machine failures.

The discourse on SMEs specifically engaging in OBC BMs remains underexplored. This Publication aims to clarify this area through three primary research questions:

1. What key obstacles do SME MMs encounter in providing OBC BMs?
2. What strategies do SME MMs employ to overcome these challenges in the context of OBC BMs?
3. What advantages do SME MMs realize through the adoption of OBC BMs?

Publication IV findings

From Paper IV, we synthesized findings on the challenges, mitigation strategies, and significant benefits experienced by SME MMs in offering OBC BMs. This analysis draws from various SME MM experiences and addresses the financial, operational, and strategic dimensions of adopting OBC models, thereby answering both RQ1 and RQ2.

OBC BMs present both opportunities and risks for MMs. On the opportunity side, these models lower customers' upfront investment barriers, making high-quality machines more accessible and allowing SMEs to enter competitive and price-sensitive markets. With the support of third-party financing, SME MMs can expand their market reach and open new sales channels. OBCs also help attract niche customer segments seeking performance-based solutions. Operational benefits include access to real-time usage data, which supports predictive maintenance, performance optimization, and long-term customer relationships. Additionally, the ability to reclaim and refurbish machines at the end of contract periods promotes sustainability and cost efficiency.

However, significant risks accompany these benefits. Financing costly machinery under OBC BMs is a major challenge, with capital acquisition being a central concern for SMEs. Extended payback periods compared to traditional sales models increase financial exposure and threaten long-term sustainability. To mitigate these risks, many companies rely on third-party financing and structure auxiliary service contracts (e.g., installation, maintenance, training) to generate steady revenue during the contract period. Operationally, customer underutilization of machines can reduce profitability. Some companies mitigate this through penalty clauses and minimum usage agreements. Intellectual property protection poses additional challenges, especially in

markets with weak enforcement. In response, SMEs often adopt strong contractual safeguards and target markets with reliable IP regimes. Continuous access to machine data is also essential for ongoing innovation, customization, and customer satisfaction but requires solid data infrastructure and trust-based customer cooperation.

The findings provide insight into how MMs can design effective OBC BMs. A key design strategy is the integration of financial mechanisms, such as partnerships with leasing companies or financial institutions, to reduce the capital burden. companies also combine OBC BM offers with service-based revenue streams to stabilize cash flow. Usage-based pricing models—aligned with machine output or performance—ensure that revenue corresponds with the value delivered to the customer. Where usage is uncertain, contractual mechanisms such as minimum usage clauses or penalties for underutilization are employed to protect the provider's financial position.

In terms of operations, real-time monitoring and data access are crucial. These allow for better service delivery, predictive maintenance, and continuous improvement of both product and service. Strategically, SMEs design OBC BMs with strong IP protection measures and are selective in their market entry. Some also integrate sustainability into the design by reclaiming and refurbishing machines, lowering the need for new investments and supporting circular economy goals.

Despite the challenges, SME MMs can successfully adopt OBC BMs through a combination of innovative financing, carefully structured operational strategies, and a clear focus on efficiency, value delivery, and long-term customer relationships. OBC BMs offer substantial potential for enhancing competitiveness and driving sustainable growth in the manufacturing sector.

5 DISCUSSION AND CONCLUSION

5.1 Discussion

Overall Objectives of Dissertation

The primary objective of this dissertation is to define and analyze novel opportunities presented by outcome-based contracting models in the manufacturing sector, especially in machine building. It aims to comprehensively explore how both SMEs and larger manufacturing entities can derive benefits from these business models. The dissertation provides a more detailed contribution, specifically tailored for SMEs. Furthermore, this dissertation provides an in-depth examination of these opportunities, while concurrently identifying potential risks associated with outcome-based contracting business models (OBC BMs). It also proposes strategies for the effective mitigation of these risks.

Overall, the dissertation enriches business model research from three distinct perspectives. Firstly, it introduces novel insights into Pay-Per-X Business Models (PPx BMs). Secondly, it provides an analysis from the perspective of MMs. Thirdly, it examines the implications and applications of these models specifically for SMEs.

5.1.1 Research Question 1

Introduction to the research question and its relevance

This dissertation addresses the first research question: *What kind of opportunities (benefits and risks) do Outcome-Based Contract (OBC) business models offer for machine manufacturers (MMs), including SMEs and large companies?* The question is particularly relevant in the context of increasing servitization and digitalization in manufacturing. OBC business models reflect a strategic shift from selling products to delivering measurable outcomes, offering benefits such as recurring revenues, stronger customer loyalty, and enhanced market competitiveness (Baines & Lightfoot, 2014; Visnjic et al., 2016). At the same time, these models introduce significant risks, including performance uncertainty, complex service delivery, and high capital investment (Ng & Nudurupati, 2010; Datta & Roy, 2011).

This topic is of importance for both large companies and SMEs. While SMEs often face resource constraints, they also possess strengths such as organizational agility and customer proximity, which may position them advantageously in adopting innovative business models (Gebauer et al., 2017; Kowalkowski et al., 2015). Industry 4.0 technologies, particularly IIoT and predictive analytics, now allow real-time outcome monitoring, which is central to the success of OBC models (Porter & Heppelmann, 2014; Delsing, 2017). This dissertation therefore contributes to both theoretical and practical discussions on how different types of companies can navigate the transition toward value-based offerings.

Key findings from publications related to RQ1

In Publication I, we found that a specific type of OBC BM, the Pay-Per-Output (PPO) model, is increasingly being adopted by SMEs as a means to generate new revenue streams and enhance transparency in value delivery. This model is well-suited to smaller companies due to their flat hierarchies, adaptability, and close customer interaction. Implementation processes were typically iterative and adaptive, driven by limited resources but supported by quick decision-making and minimal internal resistance. PPO models were often developed in tandem with digitalization, especially with automation systems (AS). In companies starting from a low-tech base, automation capabilities evolved alongside the business model. In contrast, more technologically advanced companies required only incremental modifications. Across cases, the role of IIoT and data collection proved central to enabling PPO, although challenges such as connectivity, data security, and user interface design remained. Interestingly, the development of the business model had a notable impact on the direction and progress of the associated technology.

Strategically, PPO enabled SMEs to access new markets, lower entry barriers for customers, and offer high-performing products with reduced upfront costs. In some cases, PPO accounted for a significant and growing share of total business. The agility of SMEs, combined with their ability to tailor offerings, allowed them to implement PPO in ways that are less feasible for larger companies constrained by internal complexity.

However, Publication I also identified key limitations: constrained financial and human resources slowed structured planning and technological development, and companies faced challenges in convincing customers of the value of new models. Nevertheless, the dissertation concluded that PPO, when tightly integrated with automation and outcome monitoring, represents a viable and promising strategy for SMEs in B2B manufacturing.

In Publication II, we extended this analysis and found that rapid sales growth was strongly associated with, and influenced by, the adoption of broader Pay-Per-X (PPX) models. As a key component of Outcome-Based Business Models (OBMs), PPX enabled companies to expand their customer base by improving the financial accessibility of expensive machinery. Flexible pricing lowered adoption barriers, and strategic partnerships, especially with financial institutions, helped companies secure necessary funding. Particularly surprising is the way providers leverage pricing flexibility and financing not merely as sales tools, but as strategic levers to lower customer adoption barriers and stimulate long-term value creation. Moreover, the dual focus on growth and proactive risk management illustrates a more balanced and adaptive approach than typically associated with conventional product or service sales, highlighting a novel blend of financial innovation and customer-centric design within PPX models.

Although profitability under PPX models is often limited in the short term due to high initial costs and reliance on external funding, it tends to increase significantly once initial investments are amortized. Over time, PPX models can outperform traditional sales models, especially when operating costs are effectively managed.

Four core mechanisms were identified as key to PPX-driven growth: strategic expansion to new and existing customers, pricing flexibility, financing support, and risk management to protect both providers and clients in uncertain conditions. These findings are interesting because they reveal how outcome-based models, specifically pay-per-output (PPX) models, extend beyond traditional service logic by addressing both business growth and resilience in capital-intensive sectors. PPX models, a subset of outcome-based business models

(OBC BMs), tie revenue directly to performance or output rather than product ownership, making them particularly appealing in machine manufacturing where customers may be hesitant to invest upfront in expensive equipment.

The implementation of PPX plays a crucial role in enabling access to advanced machinery while spreading financial risk between provider and customer. It allows providers to differentiate themselves through service integration, while customers benefit from reduced capital expenditure and aligned performance incentives. Publication II highlights that organizational size plays a mixed role in implementing PPX models. Smaller companies often benefit from agility, faster decision-making, and the ability to customize contracts more closely to client needs. However, their limited internal financing capacity can hinder independent scaling, forcing them to rely on external distributors, financiers, or service partners. While these collaborations can help bridge capability gaps, they often come at the cost of reduced profit margins and increased operational complexity. An important and somewhat surprising finding was the significant influence of financing costs on the overall profitability of PPX models, underscoring the central role that financial design plays in the success of outcome-based strategies. This makes PPX particularly interesting, as it highlights the intersection of strategic innovation, financial engineering, and collaborative ecosystem design—factors not typically emphasized in conventional product-based business models.

OBC BMs represent a broader category of business models in which value is delivered based on the achievement of agreed outcomes rather than the delivery of products or services alone. These models shift the focus from ownership and transactions to performance, results, and long-term value creation. Within this broader category, Pay-Per-Output (PPX) models are a specific subset that links revenue directly to measurable units of performance, such as machine uptime, processed parts, or production hours, rather than a fixed price or usage-based fee.

In the context of this dissertation, the focus is on capital-intensive PPX models applied in the machine manufacturing sector. These include arrangements such as pay-per-part, pay-per-use, and availability-based contracts where customers pay only when machines produce output or meet defined performance criteria. These PPX models retain key characteristics of OBC BMs, such as shared risk, long-term engagement, and outcome alignment, but are particularly distinctive in how they operationalize outcomes through quantifiable metrics tied to machine performance.

Both Publications (I and 2) emphasized that while OBC BMs offer strong strategic benefits, they also introduce substantial challenges, particularly for SMEs. The resource intensity of implementing OBC BMs, including infrastructure, skilled personnel, and digital systems, can be a major hurdle. Long payback periods create cash flow vulnerabilities, and the requirement to deliver consistent performance over time adds further operational pressure (Hypko et al., 2010a).

Other complications include the difficulty of protecting intellectual property when customers retain possession of machines, the need to ensure machine utilization aligns with contract terms, and data security concerns in cloud-connected environments. The iterative and unstructured nature of implementation further complicates the process for SMEs, who often lack access to standardized roadmaps or institutional experience. In contrast, larger companies typically have the resources to manage OBC adoption more systematically.

Despite these challenges, the findings suggest that SMEs can succeed with OBC BMs, even though they are often difficult to implement due to factors such as increased risk. Success can be achieved through various

strategies, including leveraging external partnerships, adopting hybrid revenue models, and tailoring service contracts to balance risk and return.

In conclusion from RQ 1, this dissertation shows that OBC BMs hold strong potential for MMs, particularly SMEs. These models support growth, profitability, customer satisfaction, and sustainability. However, they also introduce considerable financial, operational, and technological risks. Drawing on insights from paper one and paper two, successful OBC BM implementation requires aligning business model innovation with advanced automation capabilities and carefully managing constraints through strategic partnerships and adaptive planning.

5.1.2 Research Question 2

Introduction to the research question and its relevance

This dissertation addresses the second research question: *How can Machine Manufactures (SME and larger companies) design OBC BMs?* This dissertation is highly relevant as it addresses a pressing challenge in the manufacturing sector: how MMs, also SMEs, can design and implement OBC BMs in the context of increasing servitization and digital transformation. As companies move away from traditional product-sales models toward service- and outcome-oriented strategies, there is a growing need for structured frameworks to guide this transition (Baines & Lightfoot, 2014; Visnjic et al., 2016).

Despite increasing academic attention, the practical implementation of OBC BMs remains underexplored, especially for SMEs, which often face limited resources, technological infrastructure, and organizational capabilities (Gebauer et al., 2017; Kowalkowski et al., 2013). This dissertation addresses these gaps by proposing updated design criteria that reflect current technological developments, including Industry 4.0, IIoT, and AI, which significantly affect how value is created and delivered in manufacturing (Porter & Heppelmann, 2014; Delsing, 2017).

Furthermore, the dissertation's focus on hybrid models and third-party involvement addresses one of the key concerns for SME, managing long payback periods and financial risk, making the findings not only academically significant but also immediately applicable for practitioners navigating outcome-based strategies (Gebauer et al., 2012; Kindström & Kowalkowski, 2014).

By responding to both the technological evolution of the industry and the practical constraints faced by large companies and SMEs, these results of RQ2 make a timely and valuable contribution to the fields of business model innovation and servitization.

To address the research question *"How can Machine Manufactures (SMEs and larger companies) design OBC business models?"*, this dissertation explores how MMs can structure and implement OBC BMs by examining published cases and synthesizing findings across multiple studies.

Key findings from publications related to RQ2

Publications III and IV contribute important insights into how MMs, large companies and SMEs can design and implement OBC BMs in a way that aligns with current technological and market developments.

Publication III is based on a conceptual model consisting of 20 DC for OBC BM design, 13 of which are newly identified. These criteria reflect major shifts in manufacturing and technology over the past 15 years, notably the rise of Industry 4.0, Smart Manufacturing, and the Industrial Internet of Things (IIoT). The dissertation builds on earlier frameworks such as those by Hypko et al. (2010) and Lay et al. (2009), but extends them by integrating elements such as software and data ownership, advanced digital monitoring capabilities, and dynamic pricing models. The model's criteria are categorized into four thematic groups: ownership, responsibility, payment models, and other contextual factors. This structure clarifies how different elements of OBC BMs interact and affect lifecycle profitability, feasibility, and implementation complexity. Moreover, the updated model allows for a clearer differentiation between OBC BMs and similar servitization models, which are often treated as homogeneous in the literature but in practice differ substantially in design and operational requirements.

Publication III builds on this foundation by introducing a morphological analysis designed to support the systematic configuration of OBC BMs for MMs. The analysis includes 29 DC and associated configuration options, serving as a problem-structuring tool that helps companies navigate the wide range of potential OBC BM design choices. The model was validated through a systematic literature review, expert evaluations, and interviews with six case companies from various sectors. This comprehensive validation process adds empirical depth and practical relevance to the framework. The Publication III offers both academics and practitioners a flexible and robust tool to design OBC BMs that are not only economically viable but also aligned with technological, organizational, and market-specific conditions.

While Publication III offers generalized models applicable to a wide range of MMs, Publication IV narrows the focus more to SMEs and highlights their specific challenges and strategies when offering OBC BMs. SMEs, compared to larger companies, face more pronounced financial constraints, limited operational capacity, and reduced negotiation power, all of which complicate the implementation of OBC BMs. Key challenges identified include the difficulty of owning high-value equipment, long payback periods, underutilization risks, safeguarding intellectual property, and delivering guaranteed performance outcomes. These findings resonate with previous research on servitization in SMEs (e.g., Visnjic et al., 2016; Paiola et al., 2020), which emphasizes the structural disadvantages smaller companies face in adopting service-based business models.

Additionally, in Paper 4, the proposed framework was evaluated by experts, leading to the inclusion of additional parameters to the model introduced in Paper III. Finally, Paper 4 demonstrates the benefits of the framework to design OBC BM, particularly for SMEs.

To overcome these barriers, SMEs tend to rely on a set of tailored strategies. These include the use of hybrid models that combine traditional investment-based approaches with outcome-based elements, involvement of third-party financiers or service providers to share ownership and risk, and implementation of variable pricing strategies such as performance-based payments and minimum usage fees. Additionally, SMEs make strategic use of data generated by connected machines to enhance performance monitoring and iterative improvements, which not only supports better service delivery but also fosters innovation. Expanding service contracts to include installation, training, and maintenance further strengthens revenue stability and customer relationships.

Beyond mitigation, the dissertation identifies unique benefits that OBC BMs offer to SMEs. These include improved access to high-tech markets traditionally dominated by incumbents, stronger customer retention through long-term service contracts, and enhanced sustainability via reuse and refurbishment of machine components. Importantly, these benefits help SMEs build competitive differentiation and resilience despite their structural constraints.

Taken together, these three Publications regarding RQ2 offer a comprehensive understanding of the design, implementation, and contextual challenges of OBC BMs in the machine manufacturing industry. They extend existing theory by incorporating modern digital tools and offering validated frameworks, while also addressing the practical realities faced by different types of companies. As a whole, the dissertation RQ2 answers highlights how carefully designed OBC BMs can serve as a strategic lever for innovation, competitiveness, and sustainability in manufacturing.

5.1.3 Overall discussion and conclusion of the dissertation

Theoretical implications towards literature

This dissertation offers a novel set of theoretical implications for the literature on OBC BMs, servitization, and business model innovation (BMI), with a specific focus on small and medium-sized enterprises (SMEs) in the MM. Drawing on empirical evidence from four research papers, the dissertation **refines, extends, and contextualizes existing theoretical frameworks** in multiple ways. These results were generated through a combination of longitudinal case studies, design-oriented research, and different kinds of analysis across varied SME contexts. By closely examining real-world implementation processes, business model experimentation, and ecosystem interactions, the dissertation uncovers the **mechanisms through which digital tools, customer relationships, and networked resources shape outcome-based logic in practice**. This empirically grounded approach allows the dissertation to develop nuanced, context-sensitive insights that advance theoretical understanding while remaining firmly rooted in the realities of SME transformation. **To my knowledge, previous studies have not highlighted how MM companies, especially SMEs, can benefit from OBC BMs and what kind risks there are. Surprisingly we were able to find new multiple new DC compared to the existing literature.**

Extension of OBC Business Model Research to the SME Context

Traditional research on Outcome-Based Business Models (OBC BMs) (e.g., Hypko et al., 2010a; Gebauer et al., 2012) has largely focused on large companies, often assuming the availability of substantial financial, technological, and organizational resources. Publication I **challenges these assumptions by empirically demonstrating how SMEs, particularly in the machine manufacturing sector, are also adopting OBC BMs, though through distinctly different mechanisms**. The dissertation reveals that SMEs leverage their agility, fast decision-making, and ability to serve niche markets to overcome structural limitations and enter outcome-based business arrangements. These findings suggest that current theoretical frameworks for OBC BMs, which are often tailored to the capabilities of large corporations, must be broadened to reflect SME-specific pathways, opportunities, and constraints, thereby increasing their inclusiveness and practical relevance (cf. Gebauer et al., 2017).

Building on this foundation, Publication II explores the implementation of Pay-Per-Output models, a specific subset of OBC BMs by SMEs. It shows that while SMEs benefit from flexibility and closer customer relationships by using OBC BMs, they face challenges related to internal financing capacity and scale, often requiring collaboration with external partners. Paper IV further examines the long-term viability of PPX models by integrating empirical insights with conceptual frameworks, highlighting how mechanisms such as strategic customer expansion, pricing flexibility, financing support, and risk management drive growth in PPX settings.

The Role of Company Size in OBC BMs and Servitization Research

Servitization literature (e.g., Kowalkowski et al., 2013) generally emphasizes internal capability development for transitioning from products to services. This dissertation introduces **company size as a critical structuring variable**, showing how SMEs' limited resources and capital constraints necessitate **different servitization strategies** compared to large companies. While SMEs benefit from close customer relationships and flexibility, they face challenges such as **risk aversion and long payback periods**. These findings suggest a need to refine servitization frameworks to reflect diverse implementation pathways conditioned by company size.

Extension of OBC BM Design and the Advancement of Configurational Approaches in Business Model Innovation

Existing OBC BM frameworks (e.g., Hypko et al., 2010; Lay et al., 2009) are now outdated due to the rise of digitalization and Industry 4.0. Publication III significantly expands these models by introducing **13 new design criteria, such as AI-based monitoring, data ownership, and dynamic pricing, that reflect contemporary technological realities**. These additions respond to calls for integrating digital perspectives into BMI (e.g., Baines & Lightfoot, 2013; Kohtamäki et al., 2019), enhancing the relevance and applicability of OBC BM research to the current industrial landscape. Publication IV introduces a **morphological framework comprising 29 interrelated configuration options for OBC BMs**. This contributes to configurational theories of business models (Fiss, 2011; Zott & Amit, 2010) by providing a systematic method to explore and compare viable business model variants. It supports the theoretical view that business models are interdependent and path-dependent systems, offering scholars a new tool for fine-grained theorization of BMI as a configurational process.

Contextualization of BMI in SMEs Under Resource Constraints

Publication IV represents a novel contribution by addressing the critical gap in the literature by theorizing **how SMEs engage in BMI under significant limitations**. Findings show that **SMEs employ hybrid strategies, such as staged adoption, modular services, and third-party partnerships, to gradually adopt OBC BMs**. These insights reinforce emerging research that emphasizes experimentation, adaptation, and contextual limitations in BMI (Visnjic et al., 2016; Bustinza et al., 2013; Paiola et al., 2021), furthering an inclusive understanding of innovation in constrained environments.

Theoretical clarification of OBC BMs within the servitization spectrum

This dissertation adds conceptual clarity to the servitization literature by more clearly distinguishing OBC BMs from other types of servitized offerings. By categorizing OBC BM design decisions into **four key dimensions; ownership, responsibility, payment,** and context, the dissertation provides a structured framework for

identifying what makes OBC BMs distinct. This new way of classification highlights how OBC BMs shift value logic from delivering activities to delivering measurable outcomes, and how this **shift implies different risk-sharing, contractual, and operational arrangements compared to more traditional product-service systems**.

This contribution refines existing servitization theory by offering a clearer typology of service-based business models, enabling more precise theoretical differentiation, particularly within the domain of OBC BMs. The typology was developed **through an iterative process combining literature synthesis with empirical insights drawn primarily from Publications III and IV.** These papers integrate data from qualitative interviews, workshop discussions, and morphological analysis to systematically map and categorize different OBC BM configurations, ranging from basic pay-per-use arrangements to more complex performance- and availability-based contracts.

What is particularly new and surprising is the extent to which conceptual ambiguity has persisted in literature despite the growing adoption of OBC BMs in practice. Previous studies often used overlapping or inconsistent terminology (e.g., "servitization," "performance-based contracting," "functional sales"), which has limited the field's ability to compare cases or build cumulative knowledge (Tukker, 2004; Rabetino et al., 2018). This dissertation **contributes by clarifying the distinctions between different service-based models and introducing a structured framework that highlights how factors such as risk allocation, performance metrics, revenue logic, and digital enablement vary across model types.**

This enhanced typology not only supports more rigorous comparative empirical analysis but also improves theoretical consistency across studies, addressing a longstanding gap in servitization and business model innovation literature. It offers a valuable foundation for future theorizing around business model evolution, value co-creation between manufacturers and customers, and the enabling role of digital technologies, such as IoT and data analytics, in scaling and sustaining performance-based models. The surprising insight here is that even among companies with similar technological capabilities, the choice and configuration of OBC BMs can differ significantly, depending on contextual factors like customer readiness, financing structures, and risk tolerance, underscoring the need for more nuanced, empirically grounded frameworks

SMEs and large companies are different regarding OBC BM design and adaptation

There are important **theoretical differences between SMEs and large companies in their adoption of OBC BMs. SMEs tend to rely on agility, close customer relationships, and external partnerships to implement OBC BMs, often through hybrid and incremental approaches**. In contrast, large companies benefit from internal capabilities, structured implementation processes, and broader strategic resources, allowing for more comprehensive and integrated OBC BM adoption.

SMEs face greater resource constraints and are generally more risk-conscious but compensate with faster decision-making and niche market targeting. Large companies, while slower to adapt due to organizational complexity, are better positioned to absorb risk and invest in long-term digital infrastructure. These findings suggest a need for size-sensitive theoretical models that account for differing pathways, constraints, and strategic logics in servitization and business model innovation. Results position the dissertation as a clear step forward in bringing classical servitization frameworks with modern, digitally enabled, and context-sensitive approaches to OBC BMs in MM.

Overall contribution of OBC BMs and Digital Servitization: Interesting and new findings

This dissertation contributes to theory of OBC BM design and implementation by advancing the understanding of how digital servitization and business model development intersect, particularly in the context of OBC BMs. A key theoretical implication is the empirical demonstration that digital technologies, such as sensors, connectivity, AI, and IoT, do not merely support servitized offerings, but fundamentally **reshape the logic of value creation and capture.** These findings support and extend existing propositions (e.g., Ziaee Bigdeli et al., 2018) that digitalization transforms the core architecture of business models. Importantly, digital capabilities were shown to be integral in enabling OBC BMs, also for SMEs, by creating **transparency in value delivery and making performance-based revenue models operationally feasible**. This highlights digitalization not as a secondary enabler but as a central and active force in driving business model innovation in outcome-oriented contexts.

Another important and interesting theoretical implication is the reversal of the traditional technology-push narrative. **Surprisingly, the findings showed that business model development can actively steer technological development**. This represents a novel contribution, since companies were found to make strategic technology choices based on the needs and logic of emerging business models, rather than developing business models as a byproduct of available technologies. This insight adds novel nuance to existing servitization and innovation literature by emphasizing a bidirectional relationship between technological and business model innovation. Furthermore, the identification **of financing costs as a critical determinant of profitability in OBC BMs** introduces a new dimension to business model theory, positioning financial design as a core component of BMI rather than a supporting constraint.

The dissertation also reveals the increasing complexity of business model design under digital servitization. To find answers to the research gap how OBC BMs can create new opportunities to in MM, **Publication III identifies a surprisingly wide range and huge number of new DC relevant to OBC BM implementation**, suggesting that digital servitization introduces a broader and more dynamic set of variables into the design space than previously recognized. This contributes to the literature by emphasizing the multidimensional nature of BMI in digitalized industrial contexts. Overall, the findings suggest a need for theoretical models that better account for the co-evolution of digital technologies, financial structures, and business model logic, particularly in the SME sector, where agility and contextual adaptation play a central role.

Limitations and Generalizability

This dissertation focused on a relatively small group of companies overall. On the other hand, they were carefully selected to represent their respective reference groups. The dissertation results pertain to this group, and it would be beneficial to confirm and further validate these findings in future studies. However, the consistency of results across different studies is strong, and therefore the overall findings are significant and extend the existing research in the field.

Practical implications

This dissertation provides clear, actionable insights into how MMs, particularly SMEs, can successfully design and implement OBC BMs in the evolving context of digitalization and servitization. Managers can benefit from this dissertation in several concrete ways. First, the findings highlight how OBC BMs can serve as strategic

tools for unlocking new revenue streams, deepening customer relationships, and enhancing long-term profitability by shifting from one-time product sales to performance- or output-based value delivery. This is especially relevant in capital-intensive industries, where customers increasingly prefer solutions that reduce upfront investment and align provider incentives with actual performance outcomes.

However, the dissertation also shows that the successful implementation of OBC BMs is not a one-size-fits-all effort, it requires careful alignment between a company's digital capabilities, strategic objectives, and contextual constraints such as industry norms, customer readiness, and financing structures. For managers, this means that before launching OBC BM initiatives, it is essential to assess whether the organization has the data infrastructure, monitoring tools, and service culture required to support outcome-based delivery. Equally important is understanding the readiness and expectations of target customers, as well as the financial implications of revenue deferral and shared risk.

These insights are grounded in empirical evidence from four research Publications that combine case studies, design-oriented methods, and expert interviews with machine-manufacturing companies. The dissertation draws from both successful and challenging implementation efforts to identify key enablers and barriers. For example, it shows how SMEs can leverage their agility and close customer relationships to tailor OBC BM contracts more effectively than larger companies, while also identifying the limitations they face in financing and scalability. Through cross-case analysis and active engagement with practitioners, the dissertation provides a roadmap for managers to evaluate their readiness, design suitable contract structures, and establish partnerships, such as with financiers or service providers to fill capability gaps.

Ultimately, this dissertation equips managers with a structured understanding of what makes OBC BMs work in practice, why size and context matter, and how digital tools and strategic focus can be harnessed to turn outcome-based models from conceptual ideals into viable business opportunities.

A practical tool introduced in this dissertation is the morphological box, which supports structured business model innovation by breaking down OBC BMs into key decision dimensions, such as ownership, responsibility, payment logic, and delivery context. This tool helps companies systematically explore and evaluate different business model configurations based on their strategic priorities and operational capabilities. One clear advantage of the morphological box is its ability to make abstract business model design choices tangible, allowing teams to visualize trade-offs, identify feasible pathways, and facilitate cross-functional discussion between technical, strategic, and commercial perspectives. For SMEs, it offers a simple yet powerful framework for business model exploration without requiring deep theoretical expertise or major consulting support.

What is surprising, however, is how the use of the morphological box often challenged companies' existing assumptions, for example, revealing hidden constraints in their payment structures or overlooked opportunities in reassigning responsibilities between provider and customer. In several cases, the tool prompted unexpected strategic shifts, such as expanding service scope or revisiting the technological roadmap to better align with desired value propositions. It also exposed how internal alignment, between R&D, sales, and management, is often lacking when moving toward outcome-based logic, and how a shared design framework can improve communication and commitment.

Overall, the dissertation shows that implementing OBC BMs is not just about adding digital tools or bundling services; it requires a deliberate, structured approach to rethinking the entire business model. The

morphological box offers a practical and flexible way for companies to do this, helping them navigate complexity and make informed choices that reflect both customer needs and organizational capabilities.

Business Model Innovation Through Outcome Orientation

OBC BMs are increasingly used by manufacturers to shift from product sales to value-based offerings. Outcome-based models lower entry barriers for customers and enable companies to generate recurring revenue streams. These models are particularly effective in supporting business model innovation, as they allow manufacturers to differentiate themselves in competitive markets by offering transparency, performance-based pricing, and greater alignment with customer outcomes. An interesting implication in this dissertation is how it demonstrates that adopting an outcome-oriented logic enables also SMEs to innovate their business models in ways that enhance competitiveness. By aligning value creation and revenue with customer outcomes rather than products or activities, companies can differentiate themselves, build stronger customer relationships, and enter new markets. The outcome-based approach also encourages more focused use of digital tools and data, supporting continuous improvement and more responsive service delivery. For SMEs, this form of business model innovation offers a scalable and flexible path to create value beyond traditional product sales.

Agility and Adaptation as Competitive Advantages

Smaller companies often excel in implementing OBC BMs due to their organizational agility, fast decision-making, and close customer relationships. These strengths enable more rapid experimentation and adaptation of new models, especially in niche markets or customer-specific contexts. However, challenges such as limited internal financing, long payback periods, and resource constraints require SMEs to pursue incremental adoption strategies and avoid overextension.

The Critical Role of Digital Infrastructure

The success of OBC BMs depends heavily on robust digital capabilities. Technologies like IIoT, automation, AI-based monitoring, and predictive analytics are not just operational tools, they are strategic enablers of value delivery and contract performance. Companies must invest in systems that enable real-time data collection, performance tracking, and customer reporting to meet the requirements of outcome-based contracts and to build trust with customers.

Structured Business Model Design and Decision-Making

Designing an OBC BM is inherently complex, involving decisions around risk sharing, pricing logic, data governance, service delivery, and revenue models. Structured frameworks and decision-support tools, such as configuration models and strategic design criteria, can significantly lower the complexity and risk of failure. These tools enable cross-functional teams to test and align business model elements and reduce the need for trial-and-error approaches. These tools are a significant practical result of this dissertation.

Hybrid and Modular Implementation Strategies

Rather than adopting fully outcome-based offerings from the outset, many companies succeed through hybrid models, blending traditional product sales with service-based performance contracts. This staged approach reduces financial exposure, allows learning over time, and provides flexibility in how and when outcome logic is integrated into the business. A hybrid model can serve as a stepping stone toward a fully developed OBC BM and is often more easily accepted by customers in the early stages of adoption.

Ecosystem Collaboration and Customer Relationships as Drivers of Long-Term Value

External partners, such as financial institutions, digital solution providers, and service integrators, play a crucial role in enabling OBC BM adoption, especially for SMEs. These partnerships can provide access to capabilities, funding, and customer networks that would be difficult to build in-house. Collaboration can also reduce the risk burden and accelerate implementation timelines. One of the most interesting examples is how financing can be arranged through a third part inside ecosystem. OBC BMs require a shift from transactional sales to relationship-based service delivery. Building long-term trust through transparent communication, shared performance targets, and responsive support is essential. Performance-based contracts can also generate valuable customer data, which in turn enables more personalized service, longer relationships, and broader solution offerings over time. Access to additional customer data can provide a significant competitive advantage, especially in challenging market conditions.

Strategic Fit and Sector Relevance

These models are especially relevant in capital-intensive, B2B industries, such as industrial equipment manufacturing, where customers are increasingly seeking value-in-use rather than ownership. Outcome-based models align well with longer asset lifecycles, high service needs, and customer expectations for reliability and cost predictability.

Enabling Long-Term Competitiveness and Sustainability

Outcome-based strategies not only support business growth but also drive sustainability goals. By promoting longer machine lifecycles, optimized usage, and circular practices such as machine reuse or recycling, these models align with broader industry transitions toward greener, service-based economies. Green values are a significant additional benefit of using an OBC BM, as overall efficiency and resource utilization improve.

Overall implications

Overall findings suggest that OBC BMs offer substantial strategic benefits, including access to new markets, stronger customer relationships, and more stable revenue streams. However, they also present non-trivial challenges related to financial risk, operational complexity, and digital readiness. Success depends on a company's ability to combine structured planning with adaptive execution, align internal capabilities with external support, and design models that are both scalable and customer-centric. With the right tools,

partnerships, and mindset, companies of all sizes, especially SMEs, can implement OBC BMs effectively and competitively.

5.2 Academic contributions of publications to the research questions

The purpose of this dissertation is to explore how outcome-based contracting (OBC) business models (BM) can be effectively designed and implemented in machine manufacturing (MM) companies. This exploration emphasizes key DC, challenges, mitigation strategies, and the benefits associated with OBC, particularly in the context of both large companies and SMEs. Bearing this in mind, all the Publications contribute to advancing the literature at the intersection of OBC BMs, machine manufacturing, and decision-making frameworks. They provide novel insights into the design of OBC BMs, the identification of critical DC, and the practical implementation of OBC BM strategies. I also explored the risks and benefits of OBC BM implementation in different sizes of companies. The main contributions of this dissertation are summarized in Table 5.

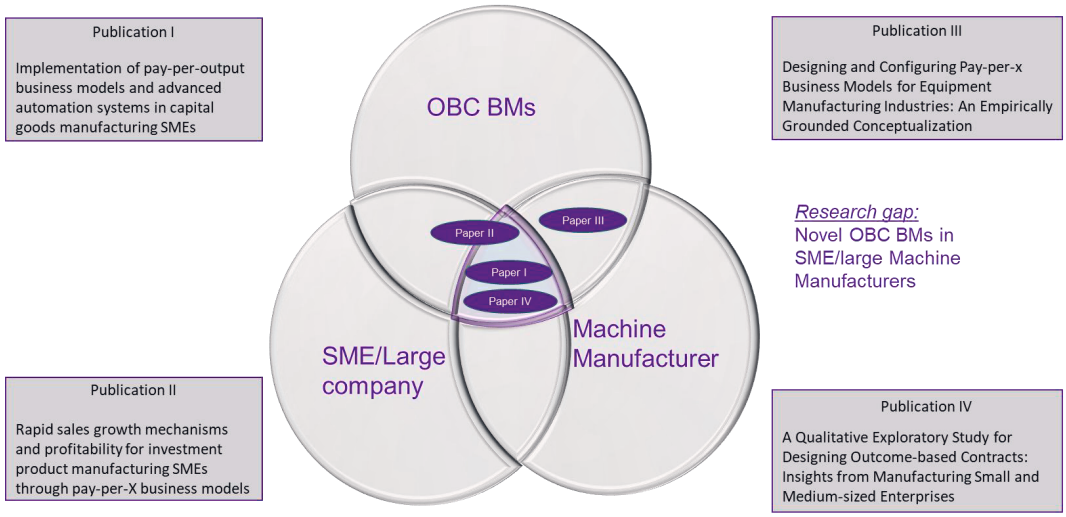


Figure 4. Linking the publications and research gap

Table 7. Publications contribution towards research questions.

Research Questions	Main academic contributions of the publications towards the research	Related publications	Related existing literature
RQ 1 - What kind of opportunities (benefits and risks) do OBC business models offer for machine builders (SMEs and large companies)?	Publication 1 enhances academic understanding of the benefits and risks associated with implementing OBC BMs in manufacturing, particularly within the machine-building sector. It also provides theoretical insight into the impact of size on the implementation of OBC BMs, particularly regarding benefits and risks. Publication 2 further expands this perspective by exploring the implications of OBC BM for SMEs.	Research Question 1 receives significant contributions primarily from Publications 1 and 2.	OBCs in Machine Building related literature: Hypko et al. 2010 Lay et al. 2009 Gebauer et al. 2017 Gebauer et al 2020 Hou, Neely 2017 Visnjic et al. 2018 SME Related literature: Müller et al. 2018 Müller et al. 2019 Child et al. 2017 Gebauer et al. 2019 Garzella et al. 2021
RQ 2 - How can machine builders (SME and larger companies) design OBC Business Models ?	In Publication 3, we synthesized existing knowledge on the critical characteristics necessary for implementing OBC BMs in the machine manufacturing (MM). The outcome of this work is a conceptual framework identifying 16 key characteristics critical for OBC BM implementation in MM. In Publication 3, we also expanded this framework through an extensive qualitative survey and in-depth interviews. This resulted in novel insights into the design process and the essential components of designing OBC BMs. In Publication 4, we investigated the significant challenges faced by SME-sized manufacturing industries (particularly machine builders) in offering outcome-based services. Additionally, we provided actionable insights into how these challenges can be mitigated and detailed the types of benefits that outcome-based services can offer to SMEs.	Research Question 2 receives significant contributions from publications 3 and 4.	Outcome Based Contracting (OBC) related literature: Hypko et al. 2010 Lay et al. 2009 Gebauer et al. 2017 Gebauer et al 2020 Hou, Neely 2017 Visnjic et al. 2018 SME Related literature: Müller et al. 2018 Müller et al. 2019 Child et al. 2017 Gebauer et al. 2019 Garzella et al. 2021

This dissertation contributes to the research on OBC BM in the MM industry in two key ways. First, it explores the opportunities, including benefits and risks, that OBC BM offers for MMs, both small and medium-sized enterprises (SMEs) and large companies. Second, it provides insights into how MMs can effectively design OBC BMs. By addressing these questions, the dissertation offers both theoretical advancements and practical guidance, supporting the adoption and implementation of innovative business models in the MM industry. The company size (SME or large) dimension is also considered in the dissertation.

Regarding the research questions (RQs), this dissertation provides two primary types of contributions: first, advancements to theoretical models, and second, significant inputs to related research streams. The specific contributions for each RQ are detailed as follows.

Contribution to theoretical models (RQ1)

From RQ1, there is little to no contribution to existing theoretical models concerning the risks and benefits of OBC BMs.

Contribution to generic OBC research streams (RQ1)

Regarding RQ1, this dissertation built upon existing generic OBC BM research streams by providing valuable insights into the advantages and challenges of adopting OBC BMs in small and medium-sized enterprises (SMEs), particularly within manufacturing industries (MIs) and among MMs. Existing research (e.g., Gebauer et al., 2012) has primarily focused on theoretical pathways for service business development but has not clearly addressed the risks and benefits of OBC BMs. Hypko et al. (2010a) conducted a comprehensive review of the literature to examine the benefits and uncertainties associated with OBC BMs from multiple perspectives. Additionally, existing research has advanced the understanding of how manufacturing companies develop the capabilities needed to transition from product manufacturing to service provision (Kowalkowski et al., 2013). Their work emphasizes service strategies, organizational elements for implementation, and the dynamic and operational capabilities driving service business development.

There are very little studies about OBC BMs in SME size companies. There are some studies about Business Model Innovation in SMEs and those also highlight that (BMI) serves as a critical factor influencing a company's survival and superior performance, particularly in rapidly growing industries. Theoretical significance of BMI has been extensively discussed but empirical studies remain limited, especially regarding SMEs (Child et al., 2017).

Gebauer et al. (2017) examined how product-focused companies build capabilities to implement OBC BMs. However, their conclusions were based on a reasoning approach that relied mainly on examples from individual case studies. This dissertation contributed to the academic understanding of the implementation of advanced OBC BMs in the context of SMEs. I found that OBC BMs provided major benefits such as access to new markets, improved profitability, and growth opportunities. For some interviewed SMEs, the OBC BM and advanced AS helped them succeed and stand out from larger competitors. For example, one company used innovative BM and AS experimentation to enter a low-competition market, selling hardware both as an investment product and an OBC BM service. Another company leveraged OBC BM to sell costly technology to customers who were hesitant to trust the performance of the machines when offered as investment products.

In this dissertation, I also demonstrated how SMEs can benefit from OBC BMs to improve financial performance, promote innovation, and enhance customer satisfaction. It highlights the strategic importance of customizing OBC BM implementations to capitalize on SME-specific strengths while addressing size-related challenges. Findings also reveal the benefits of OBC BM adoption, such as access to high-tech markets, sustainability through machine recycling, and strengthened customer relationships.

The dissertation underscores the dual role of company size (SME or large) in both facilitating and hindering OBC BM adoption. SMEs can utilize their smaller size to implement innovative OBC BMs targeting niche markets, enhancing flexibility and customer trust. However, their size also brings resource constraints, risks,

and the absence of structured roadmaps, which are compounded by the iterative nature of OBC implementation. This dissertation highlights how connectivity, advanced automation, and IIoT technologies enable strategic benefits, market differentiation, and competitiveness for SMEs adopting OBC BMs.
In addition, the dissertation emphasizes the critical role of third parties in providing resources—such as expertise, financing, and networks—that SMEs often lack, underscoring the importance of external partnerships for successful OBC BM adoption. By addressing resource limitations and operational challenges, it offers innovative mitigation strategies, such as third-party financing, hybrid models, and expanded service contracts. These approaches enable SMEs to navigate constraints like long payback periods, intellectual property (IP) protection, and performance reliability.

This dissertation contributed to the academic understanding of the major strategic benefits of advanced OBC BMs, through increasing the understanding of the generic mechanisms behind the rapid sales growth especially in MMs that produce investment products for the use of other companies in their production processes, which has been studied earlier e.g., in (Delsing, J, 2017). I added, especially by analyzing in more detail some major mechanisms towards sales growth, and mechanisms behind the profitability of PPX BM implementation. Some interesting recognized and analyzed mechanisms are related to the varied use of third parties that provide additional resources (expertise, financing, networks and contacts) to studied SMEs, which cannot find it not feasible to acquire such resources feasibly by themselves.

Furthermore, this dissertation incorporate the academic understanding of the strategic benefits realization (especially rapid sales growth and related profitability) of PPX business models, in the context of investment product companies and SMEs in particular. Earlier studies have not provided implications especially to SMEs in this context. I have demonstrated that the SME perspective mattered significantly in studied SMEs e.g. in the manner of the third part involvement, faster decision making as well as flexibility to provide best suited PPX business model contracts to the end customer.

Contribution to theoretical models (RQ2)

In Publication III we developed the proposed conceptual model, consisting of 20 important OBC-related DC that impact both lifecycle profits and risks, which extends earlier morphological OBC design models (Hypko et al., 2010; Lay et al., 2009) by identifying 16 new criteria (13 from literature review and 3 from interviews) added to these earlier OBC models that have become increasingly significant over the past 15 years. These additional criteria reflect advancements driven by industrial initiatives like Industry 4.0, Smart Manufacturing, and technologies such as affordable sensors, cloud storage, AI-based analytics, and open-source algorithms (Tsaramirsis et al., 2022). Compared to the earlier models above, which were more suited to traditional servitization approaches, this updated framework is tailored to the contemporary landscape of (MMs and OBC BMs.

The 20 DC identified in the dissertation were further categorized into four overarching themes: ownership, responsibility, payment model, and other contextual considerations. This categorization offers a structured and systematic foundation for both the design and analysis of OBC BMs. By organizing the complex set of design variables into these thematic groups, the framework helps practitioners and researchers alike to better understand the interdependencies within OBC configurations—such as who owns the asset, who is responsible for its performance, how revenue is generated, and what external factors must be accounted for. This thematic

structure also facilitates clearer communication, comparison across cases, and the modular development of business model components.

This dissertation makes significant contributions to the understanding of OBC BM by expanding on previous research. Earlier studies addressed ownership primarily in terms of the machine during and after the contract period (Hypko et al., 2010; Lay et al., 2009). In contrast, this dissertation introduces four new ownership criteria: ownership of software, production data, maintenance data, and raw materials/consumables. These additions are crucial for protecting intellectual property, fostering innovation, and ensuring the delivery of desired outcomes. They highlight the increasing importance of data and software in achieving operational efficiency and maintaining a competitive edge in modern manufacturing.

In terms of OBC BM related supplier responsibilities, previous research focused mainly on maintenance and operational personnel. This dissertation identifies six additional criteria, including responsibility for installation/setup, logistics, and skills/training, which assist in creating clear invoicing and ensuring outcome delivery. Additionally, criteria like refurbishment, upgradation, and modernization are emphasized for their role in enhancing sustainability and cost efficiency, minimizing the need for complex reverse supply chains, and supporting long-term value creation.

Finally, while earlier frameworks viewed payment models through the lens of basic transaction mechanisms, this dissertation expands on this by identifying critical additional criteria, such as penalty schemes, contract duration, and machine utilization levels. These elements are essential for fostering effective communication, aligning stakeholder expectations, and achieving successful outcomes in OBC BMs.

In the next phase, in Publication IV we expanded upon previous research (Lay et al., 2009; Hypko et al., 2010) by introducing 22 new DC for designing service-based concepts, organized into themes of ownership, responsibility, and payment models. Compared to earlier business model design approaches used in OBC design, like the Business Model Canvas (BMC), which supports general strategy design (Barquet et al., 2013; Adrodegari & Saccani, 2017; de Oliveira et al., 2018), our framework better facilitates the configuration of OBC BMs.

This phase key finding includes several important contributions to earlier academic studies. First, the validation of DC confirmed 19 out of 20 identified in the literature. A notable observation was that the case companies exclusively offered machines serving single customers, in contrast to prior studies (Bains and Lightfoot, 2014; Yang et al., 2018), which focused on movable machines capable of serving multiple customers.

Secondly, the dissertation validated eight of nine additional DC, emphasizing sustainability through practices such as recycling, scrapping, and reselling. It also refined ownership criteria, expanding them to include software, production data, maintenance data, raw materials, and consumables. These refinements address critical aspects such as IP protection, innovation, and operational outcomes.

Thirdly, the dissertation identified relevant OBC-related decision options for 29 DC, confirming the company relevance of 11 through case studies and recognizing six from the literature. However, some options, such as joint ownership of operations and end customer ownership of product data, could not be confirmed to be important for all studied companies due to variations in operational contexts.

As a last finding I identified four novel options, including flexible machine utilization, outsourcing installation/setup, and shared responsibilities for contract handling with third parties. Additionally, case companies demonstrated unique practices such as customers owning production software and providing training, which further enhanced the understanding and application of OBC BM frameworks.
Overall, this morphological OBC BM-framework enhances the understanding of OBC BMs by addressing gaps in earlier models and introducing actionable options for sustainable and flexible implementation in modern manufacturing contexts.

Contribution to the research streams (RQ2)

In SME size company category Publication IV contributes novel understanding to the literature at the intersection of OBC BM implementation and SME-specific challenges. Mittal et al. (2018) describe the key characteristics that differentiate manufacturing SMEs from large enterprises, grouping these into eight main categories: financial resources, technical resource availability, product specialization, standards, organizational culture, employee participation, alliances, and collaboration.

Additionally, MMs in SMEs often act as suppliers of components and subsystems to larger companies. This position within the value chain creates challenges for SMEs when attempting to move downstream, as they may end up competing directly with their larger customers, distributors, and installers (Gebauer et al., 2010).

OBC BM introduced new ways of sharing risks and benefits. However, SMEs often struggle with limited resources, expertise, and risk-taking capacity, which are directly tied to their smaller size compared to larger companies (Müller et al., 2018). Despite these challenges, SMEs can leverage their flexibility and quicker decision-making processes, which can offer significant advantages in implementing OBC BMs (Mittal et al., 2018).

In summary, SMEs differ from larger enterprises in many critical ways, making it difficult to directly apply business model (BM) research and service development insights—typically designed for larger organizations—to the SME context.

There are few academic studies (Kowalkowski et al., 2013; Adrodegari & Saccani, 2017; Kolagar et al., 2022) which explore servitization from the perspective of SMEs. Bhamra et al. (2018) highlight the unique needs of SMEs in service and business model development, emphasizing the importance of customized information for implementing product-service systems. Research on service models often overlooks the impact of company size on service development (Gebauer et al., 2020). For example, Oliva and Kallenberg (2003) suggest that companies should enter the service market by leveraging their installed base, yet SMEs frequently rely on distributors and installers, limiting their direct access to that base

To my knowledge, only one study (Adrodegari & Saccani, 2017) has examined the challenges faced by a Finnish SME MMs in offering OBC BMs. These challenges included changes in customer conditions, service personnel, cost estimations, and limited customer interest. The study suggested mitigating these issues through measures such as penalizing contract changes and highlighted the benefit of failure prediction for SMEs offering OBC BMs. However, it focused solely on a single case study of economic OBC BMs. The present dissertation expands on this by conducting a qualitative analysis of four diverse SME MMs, exploring their challenges and benefits during successful OBC BM implementation.

Taken together, the findings of this dissertation advance current knowledge in the fields of OBC and PPX business models. First, they deepen the existing literature by empirically demonstrating how OBC BMs operate not only in large enterprises but also in SMEs, a context that has been largely overlooked. This SME perspective highlights both opportunities—such as rapid sales growth, market entry, and stronger customer relationships—and risks, including resource constraints and risk-sharing limitations, thereby adding nuance to existing conceptual discussions (e.g., Hypko et al., 2010; Gebauer et al., 2012). Second, the findings improve current know-how by systematically identifying and validating 20+ design criteria (DC) that reflect contemporary realities such as digitalization, data ownership, sustainability, and third-party involvement. This extends prior frameworks (Lay et al., 2009; Hypko et al., 2010) and provides a more granular basis for both academic analysis and managerial application. Third, the dissertation extends the OBC and PPX literature by offering empirically grounded mechanisms that link business model design to financial outcomes, thereby bridging the gap between high-level theoretical claims and the practical realities of implementation in capital-intensive machine manufacturing. In doing so, it contributes not only to theory building in OBC BMs but also to the broader servitization and business model innovation (BMI) streams, where the role of firm size and contextual constraints has often been underexplored.

5.3 Managerial implications

This compilation of managerial insights examines the strategic implications of various BMs for companies in the manufacturing sector, particularly in machine building. It proposes value of the conceptual model value for MMs to design innovative OBC BMs tailored to specific business environments. This model guides decision-makers in structuring and developing OBC BM concepts aligned with company goals and resource constraints, such as risk tolerance and resource availability. The analysis highlights the diversity of individualized business models, including servitization, Product-Service Systems (PSS), and OBC BMs, emphasizing their differences in profit generation and risk management. Key DC include ownership and maintenance responsibilities, with traditional models like leasing differing significantly from OBC BMs, which prioritize ownership of data, software, and utilization terms. The framework offers strategies to optimize lifecycle profitability and mitigate risks by addressing ownership decisions, responsibility management, and payment model risks and rewards. These insights enable MMs to balance risks and rewards while aligning with modern customer expectations and technological advancements.

Another practical framework presented is a morphological analysis that helps MMs design OBC BMs tailored to their contexts. By utilizing 29 DC and corresponding options, MMs can systematically evaluate all aspects of OBC BM design. For example, one company's use of the morphological box demonstrated how machine ownership during use could be allocated to either customers or third parties depending on the phase, alongside the implementation of hybrid payment models (o-OBCs and e-OBCs) in the industrial gas business. This systematic approach ensures no critical element is overlooked, enabling precise and effective OBC BM configurations and development for managers.

OBC BMs offer transformative opportunities for SMEs by helping them overcome traditional barriers and enabling effective competition in high-value markets. By leveraging their inherent flexibility and creativity, SMEs managers can turn challenges into advantages, positioning themselves as key players in a rapidly evolving industrial landscape. Successfully implementing OBC BMs not only addresses immediate financial and operational challenges but also fosters innovation, sustainability, and long-term competitiveness. These

findings highlight the strategic importance of tailored approaches in unlocking the full potential of OBC BMs for SME's management to develop business further.

SMEs, in particular, have significant potential to adopt and implement OBC BMs, leveraging unique advantages associated with their smaller size. These include agility and flexibility, which allow SMEs to capitalize on opportunities that larger companies, constrained by economies of scale, may overlook. Advanced OBC BMs open new avenues for SME managers to manage and penetrate niche markets created by pay-per-output services. By strategically positioning themselves in these markets, SMEs can gain a competitive edge, deterring or even preventing larger companies from entering. The integration of advanced automation technologies and Industrial Internet of Things (IIoT) solutions further enhances the feasibility and competitiveness of OBC BMs, reshaping the competitive dynamics of SMEs in the manufacturing sector.

Another key strategy involves implementing OBC BMs with mechanisms such as flexible payment terms, third-party financing, and trust-building measures to drive rapid sales growth. These mechanisms enable SMEs to overcome traditional sales barriers and expand their market presence. However, profitability considerations remain crucial, as third-party involvement, while facilitating adoption, can limit short-term financial gains. Strategic planning is essential to optimize the role of third parties, balancing growth and profitability. SMEs should also capitalize on their agility and customization capabilities while addressing challenges like limited financial resources, ensuring sustained growth and competitiveness in increasingly demanding markets.

5.4 Evaluation of the dissertation

This dissertation is grounded in a systematic research process that combines an extensive literature review with multiple qualitative case studies to investigate OBC BMs in the MM sector. The dissertation is structured around four academic papers, applying a range of methodological approaches including qualitative thematic analysis (Papers I, II, and partially IV), as well as more quantitative and structural methods such as surveys and morphological analysis (Papers III and IV). The dissertation primarily explores the practical implementation of OBC BMs by SMEs, assessing their strategic, operational, and financial implications while also contributing to theoretical insights on digitalization and servitization in business model design. To ensure the trustworthiness of the findings, the evaluation is guided by Guba and Lincoln's (1989) four criteria for qualitative research; credibility, transferability, dependability, and confirmability.

The researcher's extensive professional experience in industrial business model development, particularly in capital-intensive SME machine manufacturing, impacted on the dissertation's credibility, transferability, dependability, and confirmability, as outlined by Guba and Lincoln (1989). I will also evaluate this impact in this section. This practical background enhanced the relevance and usability of the developed concepts and tools, while also informing key aspects of the research design and implementation. The researcher's insider knowledge of sector-specific terminology, organizational roles, and decision-making processes significantly improved the quality of data collection, especially during expert interviews, and enabled a nuanced, practice-grounded interpretation of the findings.

Moreover, the researcher's familiarity with structural and operational variations among MMs, such as differences in ownership models, product lifecycle lengths, and service capabilities, enabled the identification

of critical contextual factors that influence the suitability of various OBC BM configurations. This insight supported the transferability of findings across different types of companies. Dependability was further reinforced by methodologically sound decisions rooted in practical experience, including the development of the morphological framework, which captured real-world trade-offs and interdependencies in business model design.

In sum, the researcher's professional background was not a passive attribute but an active instrument that supported the dissertation's credibility (through contextual realism in RQ1), transferability (via pragmatic design flexibility for RQ2), dependability (through logically consistent and industry-attuned methodological design), and confirmability (via deliberate reflection and validation practices). These contributions were especially relevant in bridging the conceptual development of OBC BMs with their practical implementation in both SME and large company contexts.

To support confirmability, the researcher actively acknowledged the dual role of analyst and practitioner, employing measures such as reflexive memoing, triangulation with literature and co-authors, and validation through ThinkTank sessions. These steps helped ensure that professional familiarity served not as a source of bias, but as a valuable asset—transparently and systematically integrated into the research logic.

5.4.1 Credibility

Credibility concerns the internal validity of the dissertation, how accurately it captures and interprets the studied phenomena. In this dissertation, credibility was ensured through a combination of prolonged engagement with case companies, methodological triangulation, and systematic reflexivity.

The design of interview protocols and facilitation of ThinkTank workshops benefited from the researcher's ability to engage participants using domain-specific language and concepts. This fostered practitioner trust, improved participant engagement, and elicited richer, experience-based data. Such contextual realism added depth to the interpretation of data related to strategic intent, operational challenges, and the real-world logic behind adopting OBC BMs, directly addressing the core of Research Question 1 (RQ1).

In Publications I, II, and IV, semi-structured interviews were conducted using a purposive sampling strategy to identify informants with direct experience in outcome-based contracting and machine-as-a-service models. Thematic analysis followed established qualitative procedures, including multiple coding cycles, cross-case comparisons, and the use of qualitative data analysis to ensure consistency and transparency. Reflexive practices such as memo-writing and regular co-author discussions were employed to maintain critical self-awareness and methodological rigor.

In Publications III and IV, credibility was further supported through a theory-driven morphological analysis used to develop a comprehensive design space for OBC BMs. This iterative development process included expert validation and theoretical synthesis to ensure robustness and relevance. Paper IV, in particular, combined interviews and workshops with industry professionals to confirm the conceptual soundness of the

proposed model. Interview protocols for these engagements were grounded in existing literature (e.g., Lay et al., 2009; Hypko et al., 2010) and collaboratively refined within the research team. Data collection methods included ThinkTank sessions and Microsoft Teams interviews, creating interactive and reflective environments where participants could elaborate on or revise their inputs. To ensure accuracy, findings were validated with interviewees, peer researchers, and workshop participants. Final drafts of the Publications were also shared with case companies for review prior to submission.

The researcher's long-standing professional background in the automation and machine manufacturing sector played a crucial role in enhancing the credibility of the findings, particularly in relation to RQ1, which investigates the challenges and opportunities associated with implementing OBC BMs. This background enabled a nuanced and context-sensitive interpretation of company behaviors, strategic decisions, and trade-offs that might otherwise have been overlooked or misinterpreted.

For example, during data collection and coding, the researcher's industry experience allowed for a distinction between superficial and substantive benefits and risks, especially relevant in Publications I and II, which examined mechanisms for sales growth and profitability under OBC BMs. The researcher's familiarity with capital-intensive B2B sales cycles, customer onboarding hurdles, and the strategic role of aftermarket services enabled a more realistic and credible assessment of OBC BM value propositions and business dynamics.

While the case-specific nature of the dissertation naturally limits statistical generalizability, the richness of the data, contextual diversity, and methodological rigor support the transferability of its key insights and frameworks. The credibility dimension thus reinforces the reliability of the dissertation's first major contribution: a nuanced understanding of both growth opportunities and risk mitigation strategies for SMEs.

5.4.2 Transferability

Transferability refers to the extent to which research findings can be applied in other contexts, and this dissertation enhances such applicability through several deliberate strategies. While the dissertation is centered on small and medium-sized enterprises (SMEs) in the capital-intensive machine manufacturing sector, it was designed to yield insights with broader relevance. Case studies were conducted with companies from Finland and Germany, chosen based on clear inclusion criteria such as B2B market orientation, product complexity, and existing experience with outcome-based or pay-per-output models. The cases represent a range of organizational types, from early-stage ecosystem participants to mature adopters of OBC BMs. This diversity enabled the dissertation to uncover how key contextual factors, such as prevailing industry norms, the readiness of customers to engage in OBC BMs, and companies' financial and investment structures, influence the feasibility and design of OBC BM implementations. By documenting each case in detail, including company size, business model configuration, digital maturity, and customer relationship characteristics, the dissertation supports analytical generalization and helps readers assess the relevance of findings to their own settings.

Transferability was further supported by careful description of the empirical context—capital-intensive machinery, SME and large firm settings, and the European manufacturing environment. This enables readers to assess the applicability of findings beyond the immediate study cases. The emphasis on contextual detail clarifies the boundaries of the contribution: while some insights are SME-specific (e.g., constraints in risk-

sharing mechanisms), others extend to OBC BM theory more broadly. Transferability therefore directly shapes the scope of the theoretical contribution and its managerial relevance.

Papers I and II include companies of varying sizes and from diverse industrial backgrounds, further increasing contextual diversity. Additionally, the concepts and frameworks developed in Papers III and IV, such as the morphological analysis and dynamic capability typology, are abstracted in a way that facilitates application to similarly situated companies and related industrial settings. Both SME and large enterprise contexts enhanced the transferability of findings by enabling the development of models and frameworks, such as the morphological matrix in Publications III and IV, that reflect variation in company capabilities, resources, and strategic constraints, linking directly to both RQ1 and RQ2.

Regarding RQ1, which examines the opportunities and risks associated with OBC BMs, the findings are most applicable to SMEs operating in the B2B domain and manufacturing capital-intensive investment goods such as industrial machinery, automation equipment, or energy systems. These companies typically have at least a basic level of digital readiness, such as remote monitoring, IoT-enabled machinery, or data collection capabilities, and often maintain long-term, trust-based customer relationships that are conducive to performance-based contracting. The findings are particularly relevant where there is mutual willingness between supplier and customer to share operational risks and explore new revenue streams beyond traditional equipment sales. In contrast, the findings are less transferable to companies producing consumer goods or engaged in high-volume production with short, transactional customer relationships, as well as to organizations lacking digital infrastructure or whose clients insist on asset ownership (for example, public sector entities constrained by regulation or rigid procurement structures).

With respect to RQ2, which explores how MMs can design outcome-based business models, the results are most relevant to companies seeking to formalize and structure their business model development processes—particularly those making deliberate decisions about ownership arrangements, pricing logic, and responsibility allocation. The findings support organizations aiming to systematize complex design choices, especially when using tools such as morphological analysis to frame decision-making. The developed frameworks are useful for SMEs that are interested in building modular, customer-centric service offerings while minimizing risk during the planning phase. This is especially important in sectors characterized by long product life cycles, where outcome-based models have a direct influence on maintenance, availability, and operational integration—examples include energy systems, logistics equipment, or construction machinery. Conversely, the findings have limited relevance in businesses that rely on one-off sales or standardized product offerings, where individualized outcome-based logic is impractical. They are also difficult to apply in companies with fragmented or unclear decision-making processes, or where strategic intent and capability for business model innovation are lacking. This includes micro-enterprises without IT support or those unable to collect and interpret customer usage data, factors essential for enabling shared value creation under OBC BMs.
The researcher's industrial background provided additional know-how that helped shape the development of concepts and tools, ensuring their practical relevance and usability. While the case-specific nature of the dissertation naturally limits statistical generalizability, the richness of the data, contextual diversity, and methodological rigor together support the transferability of its key insights and frameworks. For example, the contrastive insights about financial limitations, ownership risk, and lifecycle considerations between SMEs and larger companies were not only grounded in the empirical material but also interpreted through the lens of the researcher's cross-scalar business experience. In practical terms, the outcome-based design framework was built to accommodate real-world contextual variability because the researcher was aware, through professional practice, of what is actually adaptable in manufacturing business models.

In summary, the dissertation's findings are most transferable to industrial B2B MMs, particularly SMEs, that possess a certain level of digital capability and are motivated to develop scalable, performance-based service models. Theoretically, the research contributes by clarifying how firm size, contextual constraints, and sectoral conditions shape the design and feasibility of OBC BMs—insights that extend OBC theory beyond generic servitization discussions. Managerially, the findings provide actionable guidance for SMEs and large firms on structuring ownership arrangements, risk-sharing mechanisms, and pricing logics that are viable in capital-intensive industries. At the same time, the careful documentation of empirical context delineates the limits of applicability: while some contributions remain SME-specific, others can be generalized to OBC BM theory and practice more broadly.

5.4.3 Dependability

Dependability reflects the reliability, methodological rigor, and transparency of the research process, all of which were carefully upheld throughout this dissertation. Dependability was addressed through systematic documentation of the research process, methodological transparency, and explicit reasoning for methodological choices across five publications. This strengthens, for example, the confidence in the conceptual model for OBC BM design (RQ2), since the framework can be traced to a well-documented research logic rather than ad hoc interpretation. Dependability also underpins the replicability of the findings and increases their value as a foundation for future academic research. A transparent and traceable methodology was consistently followed across all four Publications, with each study documenting in detail the criteria for case selection, interview structures, participant roles, and analytical approaches. This ensured that the logic of inquiry was clear and that the research process could be followed, evaluated, and potentially replicated by others.

Qualitative data collection and analysis procedures were grounded in well-established methodologies. In particular, thematic coding based on Corbin and Strauss (2008) was applied systematically, with clearly defined coding schemes, multiple coding cycles, and iterative refinement of themes to ensure consistency and reproducibility. The involvement of multiple researchers during the coding and analysis phases further contributed to dependability by allowing for independent interpretation and subsequent cross-validation of results. In several cases, preliminary findings were reviewed collaboratively in research meetings, where discrepancies were discussed and consensus was reached, enhancing interpretive reliability.

Quantitative and conceptual elements of the dissertation, especially the development of the morphological matrix in Publications III and IV, were approached with equal methodological care. These frameworks were built through iterative cycles of literature synthesis, expert input, and practical validation. Feedback loops—both internal, through the research team, and external, via industry stakeholders—played a key role in refining the conceptual clarity and applicability of the developed tools.

From the perspective of the dissertation's research questions, this methodological consistency and rigor directly supported the investigation of both RQ1 and RQ2. For RQ1, which explores the challenges and opportunities companies encounter when implementing outcome-based business models (OBC BMs), dependable data collection and analysis processes enabled the identification of recurrent patterns and contextual distinctions

that reflect actual industry dynamics. The use of consistent interview guides and coding procedures across multiple companies and cases ensured that findings were not isolated artifacts but grounded in systematically obtained and triangulated evidence.
For RQ2, which addresses how OBC BMs can be designed and operationalized in practice, dependability was equally crucial. The structured approach to developing the morphological matrix—based on a rigorous review of academic and practitioner literature, combined with iterative input from domain experts—ensured that the resulting design space was both theoretically robust and practically useful. The transparent documentation of this process, including literature screening methods, categorization logic, and expert feedback mechanisms, allows others to trace the analytical path and assess the reliability of the conclusions drawn.

The literature review component of the dissertation further reinforces dependability. Database selection, keyword strategies, time frame limitations, and inclusion/exclusion criteria were all explicitly documented, enabling the review to be assessed or replicated independently. This was particularly valuable for RQ2, as the literature formed the foundation for identifying relevant design variables, business model configurations, and implementation practices.

To further enhance reliability, one researcher served as an independent auditor, reviewing coding interpretations and thematic conclusions without prior exposure to raw interview data. This added an additional layer of objectivity and minimized the risk of confirmation bias. The co-authorship model and the academic peer review process for each Publication functioned as a broader audit trail, contributing to the methodological accountability and dependability of the findings.

In sum, the dissertation's dependability rests on systematic documentation, methodological transparency, and rigorous validation procedures. Academically, this ensures that the findings—particularly the conceptual model for OBC BM design—can serve as a credible basis for future research. From a managerial perspective, dependability strengthens confidence that the frameworks and insights are not ad hoc but grounded in a robust and replicable research logic, thereby enhancing their practical relevance for firms considering or implementing OBC BMs

5.4.4 Confirmability

Confirmability relates to the objectivity of the dissertation and the extent to which its findings are grounded in the data rather than shaped by researcher bias. This dissertation addressed confirmability through a range of reinforcing strategies aimed at ensuring that insights emerged from empirical evidence and participant perspectives, rather than from the researcher's personal assumptions or preconceptions.

A clear audit trail was maintained across all four Publications, systematically documenting key methodological decisions, coding logic, and the development of core insights. This included records of how interview data were categorized, how themes evolved across coding cycles, and how conceptual frameworks were iteratively refined. Such transparency ensured that other researchers could trace the analytical path and assess the neutrality and integrity of the findings.

Triangulation was another key mechanism supporting confirmability. Multiple data sources were integrated, including semi-structured interviews, ThinkTank workshops, industry documents, academic literature, and internal company materials. This multi-source approach enabled cross-verification of findings and the

identification of inconsistencies or divergent viewpoints, which were critically analyzed rather than smoothed over. For example, practitioner insights gathered through workshops were compared with both academic theory and company documentation to validate emerging claims or to flag areas requiring further scrutiny.

From the perspective of the research questions, these confirmability measures directly enhanced the robustness of results related to both Research Question 1 (RQ1) and Research Question 2 (RQ2). For RQ1, which investigates the practical challenges and opportunities associated with implementing outcome-based business models (OBC BMs), triangulation allowed the researcher to cross-check claims about performance risks, contractual tensions, or value logic from various stakeholder standpoints, thus reducing the risk of relying on single-source interpretations. This was particularly important given the complexity and contextual sensitivity of strategic and operational decision-making in industrial settings.

For RQ2, which explores how OBC BMs can be designed and operationalized, confirmability was strengthened through the synthesis of empirical data and conceptual frameworks derived from theory and practice. Industry reports and practices were critically reviewed and cross-referenced with academic literature to mitigate the influence of commercially motivated narratives. The resulting design elements and model structures were therefore not merely theoretical constructs or practitioner anecdotes, but products of careful validation across diverse sources. This enhanced the objectivity and credibility of the design recommendations presented in Publications III and IV.

Throughout the research process, the researcher actively engaged in reflexivity, recognizing his dual role as both academic researcher and long-term industry insider. While this background provided valuable contextual insight (as discussed under credibility), it also introduced the potential for unconscious bias. To mitigate this, subjective interpretations were explicitly acknowledged in memos and discussion sections and always grounded in supporting data. Peer debriefings and co-author discussions served as essential mechanisms for challenging assumptions, refining interpretations, and ensuring analytical neutrality.

Regular feedback from academic conferences and peer reviewers further enhanced confirmability by subjecting the research to independent scrutiny. These engagements offered critical perspectives on methodological choices and interpretations, prompting revisions and clarifications that improved the objectivity of the final outputs.

By explicitly acknowledging subjectivity while grounding interpretations in empirical data, the study safeguards against undue influence of personal experience. This criterion therefore supports the neutrality and analytical balance of the dissertation's contributions: the theoretical framework and empirical findings are presented as academically grounded, not practitioner-biased. Taken together, these evaluation criteria affirm that the dissertation's conclusions—the identification of risks and benefits of OBC BMs (RQ1) and the empirically grounded design framework for OBC BMs (RQ2)—rest on a credible, transferable, dependable, and confirmable research process. At the same time, the limitations noted under each criterion also define the contribution's boundaries: the findings are most directly applicable to SMEs in capital-intensive manufacturing, while still providing conceptual advances that inform the broader academic discussion on OBC and PPX business models.

Taken together, the evaluation confirms that the conclusions of this dissertation—particularly the identification of OBC BM risks/benefits (RQ1) and the design framework (RQ2)—rest on a credible, transferable, dependable and confirmable research process. The limitations noted in each criterion also frame the boundaries

of the contribution: the insights are most applicable to SME contexts but provide conceptual grounding for broader OBC BM theory.

5.5 Limitations of the dissertation and future research

In this dissertation, I expanded knowledge on OBC BMs in MMs; however, there are notable limitations. One gap is the limited focus on SMEs. While OBC BMs have been studied more extensively in large enterprises, research specific to SMEs remains scarce. Many existing models are designed for larger companies and require adaptation to fit SME contexts. Although this dissertation provides new insights into SMEs, it is still limited in scope.

Another limitation is the lack of longitudinal data. The time scale of this dissertation provides only a short snapshot of OBC BM adoption, without evaluating long-term performance. Future research should explore the sustainability and impact of OBC BMs over extended periods.

Industry-specific considerations also require further exploration. While general frameworks for OBC BMs exist, variations across different manufacturing sub-sectors are not always well-documented. Additional studies are needed to address sector-specific implementation challenges and best practices.

Future research should examine how SMEs and large MMs can effectively implement and scale OBC BMs, considering their differing resources, market positioning, and goals. Comparative studies would provide insights into best practices and scalability. While most research focuses on initial adoption, long-term impact assessments on financial and operational performance are lacking. Sector-specific studies could refine OBC BM frameworks for industries such as automotive, industrial equipment, and robotics.

Technological advancements, such as AI, blockchain, and IIoT, are reshaping OBC BMs. Research should explore how these technologies enhance contract management, predictive maintenance, and customer engagement. Additionally, hybrid models that combine traditional sales or leasing with OBC BMs call for further study.

Building on the results of this dissertation, a promising research direction is the further development and empirical validation of an OBC Business Model Configurator. The dissertation outlines the foundations for such a tool, which could support machine manufacturing firms, especially SMEs, in designing context-sensitive OBC BMs. The configurator would include a purpose layer defining its role, an input layer capturing situational factors (e.g., company size, digital readiness, machine characteristics, customer expectations, ecosystem conditions), and a configuration engine guiding users through core design dimensions such as ownership, responsibility allocation, and payment logic (PPU, PPO, PPOutcome, aOBC, eOBC, oOBC). These would be supported by an intelligence layer integrating insights on risk–benefit mechanisms, capability requirements, SME constraints, and partner involvement. An output layer would translate configuration decisions into actionable results such as a business model blueprint, financial and risk assessments, and implementation roadmaps. Optional extensions, such as scenario simulation, financing modules, or readiness assessments, could further enhance strategic evaluation. Future studies should focus on refining, operationalizing, and testing this configurator in real industrial settings.

OBC BMs also introduce financial, legal, and operational risks, which can be particularly challenging for SMEs and for large MMs operating in complex supply chains. Further research should examine contract structuring, third-party financing, and regulatory compliance, as well as customer decision-making and trust-building mechanisms that influence adoption. Scalability remains another critical challenge. Studies should investigate how firms transition from pilot projects to large-scale rollout, including questions related to pricing, financing, partnerships, and regulatory alignment. Sustainability considerations also merit attention, as OBC BMs support lifecycle management, efficient resource use, and circular economy practices. Research should explore how SMEs and larger firms approach sustainability differently within OBC BM contexts.

'Finally, the sales process for OBC BM -based offerings differs significantly from traditional product sales and affects customer decision-making, budgeting, and strategic planning. Without an effective sales approach, OBC BMs cannot succeed. Future studies should therefore examine sales strategies, customer onboarding processes, and commercial capability development tailored to outcome-based offerings.

Addressing these gaps will help refine theoretical models, generate practical strategies, and improve the successful implementation and scaling of OBC BMs across machine manufacturing and related industries.

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PUBLICATION I

Implementation of Pay-Per-Output Business Models and Advanced Automation Systems in Capital Goods Manufacturing SMEs

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16th IFIP International Conference on Product Lifecycle Management (PLM), Jul 2019, Moscow, Russia.
pp.399-410, 10.1007/978-3-030-42250-9_38
https://inria.hal.science/hal-04444747v1

Implementation of pay-per-output business models and advanced automation systems in capital goods manufacturing SMEs

Abstract. Manufacturing small and medium enterprises (SMEs) are recognized as a major driving force in European Union (EU) and elsewhere both economically as well as technologically in this ever-changing manufacturing paradigm. SMEs have major difficulties in implementing digital technologies such as the industrial internet enabled technologies that can lead towards a change in the business models, especially towards pay-per-output type business models. In this paper, we have studied pioneering manufacturing SMEs that have implemented pay-per-output business models as well as the related advanced automation systems. Both case companies were able to demonstrate the benefits and difficulties that they faced because of the size (SME) during the implementation process of both the pay-per-output business model and the related advanced automation system.

Keywords: Industrial internet of things, Industry 4.0, Business models, Nonownership business model, Pay-per-output, capital goods, IIoT, Automation system, SME

1 Introduction

Manufacturing industry - like many other industries - are facing a new era which is caused by digitalization of processes. This change is affecting both products and services, as well as production lines, and increases the need for their interaction. For example, the German initiative Industry 4.0 is defining the changes very well in different operation levels.

Manufacturing Small and Medium-sized Enterprises (SMEs) are recognized as a major driving force in EU and elsewhere both economically as well as technologically in this manufacturing paradigm change. However, SMEs have major difficulties in digitalization, Industrial Internet of Things (IIoT)/Industry 4.0 and the implementation of novel business models, such as pay-per-output type business models enabled significantly by the afore-mentioned technologies. This is partly due to the fact that SMEs have different types of challenges, barriers and also benefits related to business decision making compared to large companies. While known that existing academic research concentrates almost solely on large companies in the topics of digitalization, IIoT and Industry 4.0 [1], this research cannot be used as such, or can be used only marginally by SMEs due to the special characteristics of SMEs.

There are few studies that focus on the SME perspective and supporting the SME's in their implementation of Industry 4.0/IIoT and Smart Manufacturing [2]. Furthermore, the actual implementation of IIoT and advanced Automation Systems (AS), as well as related pay-per-output type business models especially in SME-companies are

very little studied and reported in academic literature. There are existing recent studies for instance on novel advanced automation and IIoT supported or enabled services and advanced non-ownership business models, including pay-per-use (PPU) and pay-per-performance (pay-per-output/outcome (PPO)) business models (BMs). However, these studies do not consider how the relatively small SME company size matters in the implementation process. Furthermore, the advanced PPU/PPO type-of models are still extremely little adopted and made use of in SMEs: for instance, in the survey [3] of European capital goods manufacturing companies (54% of respondents were SMEs or smaller companies), only as few as 0,2% of studied machinery and 0,1% of automation companies' turnover was derived from PPU or PPO contracts. Thus, there seems to be a strong need for SME-oriented research particularly in IIoT/Industry 4.0 and advanced pay-per-use, pay-per-output and pay-per-outcome BM context. We discuss this research gap in more detail in section 2 of this study.

Even though PPU and PPO BMs have been studied in software companies and in consumer goods contexts, PPU/PPO BM use and research is still rare in capital goods manufacturing context, and related academic research is practically non-existing from the particular perspective of SMEs. To our best knowledge, this study is the first one to consider SME company size in more depth regarding its impact in the studied types of advanced business models and AS implementation in capital goods manufacturing companies, as well as in the business model and AS interaction in the case of pay-per-output type of non-ownership business models. Accordingly, our research questions were defined as follows:

RQ1 "How were the pay-per-output business models and automation system implemented in the studied pioneering capital goods manufacturing SMEs?"

RQ2 "How did the business model and the automation system interact in the implementation process?"

RQ3 "How did the SME size matter in the implementation process?"

The studied two capital goods manufacturing companies can be considered as pioneering companies in their own capital goods businesses in making use of pay-per-output business models in the SME company category.

This study brings forth some important managerial implications for SMEs. Among these are that the studied pay-per-output type of business model offers SMEs new possibilities to compete with even larger companies that have e.g. the advantage of economies of scale, by enabling them for instance to enter interesting niche markets created by pay-per-output or pay-per-outcome services. Thus, they may position themselves into new and existing markets in such ways that prevent or discourage other players to enter the same markets. Such strategic benefits are enabled or facilitated by advanced automation and IIoT.

The structure of this study is as follows: we first review existing research and the research gap in more detail. Second, we introduce the methodology of this paper, describe the cases and explain the questionnaire themes. Third, we present the results, and discuss them, leading finally into the conclusions and managerial implications.

2 Theoretical Background

2.1 IIoT based technologies and advanced Automation Systems

High level topics concerning today's production of goods and services include sustainability, flexibility, efficiency and competitiveness [4]. Many companies are currently fighting high costs in making even small changes to their ISA-95-based production automation systems and thus are calling for new models and architectures for dynamic and digitized production [5]. Several current technologies trends that are receiving substantial attention include the following: internet of things (IoT), system of systems (SoS), cyber physical systems (CPS), clouds, big data and service oriented architecture (SOA) [4].

[4, 6] show the need to extend ISA-95 framework and we decided to select the technology stack from [6] as a base for our interview, when discussing about the changes in Automation System.

Industrial internet of things (IIoT) system is a system that connects and integrates industrial control systems with enterprise systems, business processes and analytics [7]. According definition industrial control systems contain sensors and actuators and systems are typically large and complicated systems.

Former ISA-95 standard doesn't include IIoT enabled extended connectivity to the cloud and other systems [5]. That why we selected the technology stack by [6] to refer to the automation parameter changes and development in the system required by BM development.

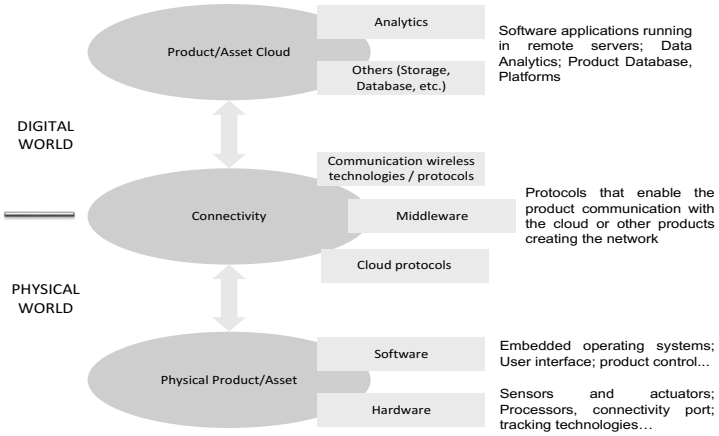

Fig. 1. Industrial Internet technology stack [6]

Into this stack we can place all hardware and software components need to realize modern and connected automation system required by Pay-per-output. In physical

product/ platform software level we included, controller parameters, fieldbus technologies and programming and runtime software as well as sensor level. In connectivity level we were interested in used hardware connection types and used protocols. The cloud level gave us information about used cloud/server types and tools used in the cloud.

2.2 Pay-per-output business model in manufacturing companies

In the manufacturing sector, Nonownership model can be defined as *"service in which customers acquire some property rights to an asset and are offered a certain degree of freedom in using this asset for a specified period of time while the burdens of ownership remain with the owner"* [8]

The above definition describes the concept of nonownership in a clear manner from the customers point of view as it talks about how a customer can use the asset but not own it, by keeping the ownership with the manufacturer. In order to take the manufacturer's point of view into consideration, the earning logic of nonownership business models has to be described. This can be done by dividing the nonownership model into pay-per-use, pay-per-output and pay-per-outcome models. Pay-per-use type nonownership model implies that the customer pays for the use of the machine and every other aspect related to the machine, i.e. ownership, installation, maintenance, upgradation, recycling is taken care of by the manufacturer. Pay-per-output type nonownership model focuses on the result of the machine use, which is usually quantified in monetary terms. Pay-per-outcome type nonownership model focuses on the value derived by the customer after using the machine provided by the manufacturer.

Literature has covered the nonownership models from various different sectors; such as, software industry [9], B2C product manufacturers such as washing machine manufacturers [10], manufactured products such as the copier and printer [11]. The above-mentioned product ranges are easy to scale because the economies of scale work very well for software products, B2C products and use intensive copiers and printers. B2B manufacturers that make equipment's or machines that are critical in customers process, such as the air-compressors or jet engines (critical components for an airplane manufacturer) have a very different risk profile when it comes to these nonownership models when compared to the above-mentioned products. There are some authors that discuss the risk profile for these kind of manufacturing companies[12, 13]. Some of the authors, [11, 13, 14], discuss the impact of IIoT on the business models of the manufacturing companies. They discuss how IIoT can enable certain business models using the business model framework. They do not discuss the impact of IIoT on specific nonownership business models, such as the pay-per-use, pay-per-output and the pay-per-outcome models in a manner that the companies can define the value proposition for every individual model. Hence, we take the morphological box designed by [15] and understand the impact of IIoT on each and every characteristic feature as well as related options of the morphological box for manufacturing companies.

In order to understand the implementation of the pay-per-output model we follow the implementation process described by [16] where the business model implementa-

tion is divided into four phases or 4I's, Initiation, Ideation, Integration and Implementation. Initiation, ideation and integration belong to the design part of the business model innovation process whereas implementation belongs to the realisation part. Initiation deals with the analysis of the ecosystem, market and the change drivers towards new business model. Ideation deals with generation new ideas related to the new business model. Integration deals with integrating the dimensions of the old business model with the new business model. Implementation deals with the actual implementation of the business model, creating trials and learnings in order to re-iterate the business model. All these phases are intertwined and require iteration at different times in order to create a near perfect business model for the customers. [16]

2.3 Manufacturing SMEs & IIoT enabled pay-per-output business model

Manufacturing SMEs are recognized as a major driving force of many economies [17]. For instance, in Germany, as well as in the EU, ca. 99% of all companies are SMEs, and only 1% are large companies [1, 18]. In addition, it is found that SME's can have a significant impact on the Fourth Industrial Revolution, which is related to the paradigm shift in Smart Manufacturing (SM) and the rise in the role of Industrial Internet and Internet of Things in the manufacturing sector [2]. However, SMEs have different types of challenges, barriers and also benefits related to business decision making, compared to large companies [2, 18]. For this reason, the Smart manufacturing and IIoT research carried out from the perspective of large companies, which forms a very extensive part of all related research, cannot be directly applied in most cases to SMEs, and partly for the same reasons, is not often considered credible and useful by SME managers. According to [2], only a few studies focus on supporting the SME's in their implementation of Industry 4.0/IIoT and Smart Manufacturing.

In this section, we discuss in more detail the overall SME specific characteristics that differentiate SME-related operations and business from larger companies' operation and business. Furthermore, we discuss the significance of SME-related research in IIoT and automation, and related novel business models, as well as the research gap of this study.

According to OECD and European Union definitions, SMEs are defined as the enterprises with less than 250 employees, and with an annual turnover of 50 million euros or less or an annual balance sheet not exceeding EUR 43 million[1].

Many studies have listed major differences between SMEs and large companies or (Large) Multi-National Enterprises (MNEs). [2] provide a good condensed description of main SME characteristics compared to large MNEs: they sum up these to include 8 overall clusters of characteristics, including the following: finance, technical resource availability, product specialization, standards, organizational culture, employee participation, alliances and collaboration.

Various studies, e.g. [1] demonstrate that academic research on Industry 4.0/IIoT focuses strongly on large enterprises [19], and only marginally on SMEs [20]. Also, a recent review study by [2] recognized a few studies to have at least some focus on SME-specific needs in the field of Smart manufacturing and Industry 4.0. Thus, there seems

[1] https://stats.oecd.org/glossary/detail.asp?ID=3123

to be a strong need for SME-oriented research, in general, in manufacturing, as well as in IIoT/Industry 4.0 context in particular.

We found one very recent paper [1] which discusses specifically IIoT/Industry 4.0 - facilitated business models and business model innovations from the specific angle of SMEs. This paper and the above finding, along with the above discussed research gaps of SME research, demonstrates the research gap that this study draws from. [1] discuss Industry 4.0 implementation and related business model implementation from the perspective of interviewed SMEs. They also discuss on general level the impact of Industry 4.0 on the business model elements of manufacturing SMEs. However, the study does not address in any specific manner the advanced non-ownership type of PPU/PPO business models and their implementation process from the particular perspective of SMEs, like our study does, but reviews the challenges and benefits of IIoT and BM's from a rather generic perspective. Second, the study reviews the above from a generic perspective, but does not address the specific benefits and challenges of nonownership business model (NOBM) implementation and does not consider which benefits and challenges are specific to SMEs. Concerning NOBM, the study raised, drawing from their interview results on manufacturing SMEs, on a more generic level, that interviewed companies were moving from being product manufacturers to becoming providers of Industry 4.0 solutions, while this allowed them for instance, concerning the value capture mechanisms to switch from traditional payments per product to "pay-per-feature, pay-per-use, or pay-per- output models". Our study will go further than this in analyzing the pay-per-output BMs and their implementation and impacts to AS from SME perspective in more detail.

There are rather recent studies, such as [13], which take a broad perspective on novel advanced automation / IIoT supported or enabled business models, such as pay-per-use and pay-per-outcome services and related business models, including also SME cases and related PPU/PPO services in the study, demonstrating that SMEs have implemented already quite advanced business models along with larger companies, but these studies do not consider more specifically how the SME company size matters in the implementation process, contrary to ours. To our best knowledge, our study is the first one to consider SME company size, as a central focus of the study, in understanding its impact in the BM and AS implementation, as well as the BM and AS interaction in the case of PPO non-ownership business models.

We used also recent literature reviews, along with our own review of current literature, in confirming this research gap, and these studies (e.g. reviews on links of IoT and BM:[21, 22], and academic studies discussing advanced automation and IIoT technologies' various roles in novel business models: [11, 14, 23, 24]) revealed no other studies considering the SME company size in particular in the context of BM (and AS) implementation.

Due to lack of resources SMEs need significantly more effort in implementation of automation concepts in production [25]. The ability and agility related to implementation in SMEs can vary quite much according to nature of product and production, available technical expertise and external collaboration. If the product the company is producing includes advanced control automation including measurements and data collection, it is much easier for and SME to apply IIoT-technologies, when some basis for the

system is already available. If the current production system is utilizing advanced solutions, these can form a basis for an IIoT -system. Very big effect on implementation process has the in-house expertise and knowledge of novel IIoT -technologies. The implementation of an IIoT-system needs multi-domain technical expertise from transducers and sensors, data transfer and storage, cloud computing, knowledge-based analytics, control, software development etc. If there are multi-skill persons who can both design and realize systems, then an SME will have big benefit in implementing novel IIoT -systems. Collaboration with other SMEs provides also one efficient path for an SME in implementation phase. Systematic collaboration and co-creation in the ecosystem is a modern way to create especially digital solutions, where all partners can concentrate on their own expertise, but at the same time contributing to common bigger objective. An IIoT-system and its implementation are very good examples for this kind of activity.

3 Research methodology

The aim of this research is to understand the implementation process of pay-per-output business model and IIoT enabled automation systems for capital goods manufacturing SMEs. To study this, we have used case study methodology, by selecting pioneering SME capital goods manufacturing companies that have implemented the pay-per-output business model and have implemented the related IIoT enabled automation systems. In order to answer the research questions appropriately, we designed a selection criterion, under which we selected companies that were capital goods manufacturing SMEs, pioneering in their business, B2B businesses, companies that had already implemented the pay-per-output business model, companies that had implemented the IIoT enabled automation system.

Based on the above selection criteria, we selected two companies, Company A and Company B from Finland. We have signed a confidentiality agreement with the companies, that does not allow us to mention their names and details of their businesses. On a broader level, they are B2B capital goods manufacturing SMEs, pioneering in their business and have implemented the pay-per-output business model as well as IIoT enabled automation system with many of their customers.

We conducted a qualitative interview session with both the companies that lasted for about 2 hours each. In both the companies we interviewed R&D managers who were responsible for strategizing the implementation of both the business model (pay-per-output) as well as the IIoT enabled automation system. As there is lack of space, we are not able to attach the entire interview questionnaire, but we will describe the major interview themes in the following paragraph.

We designed a semi-structured questionnaire with a few open questions and some specific structured questions. All the questions are categorized under the following five categories:

1. Background questions
2. Planning of the business model implementation and main drivers
3. Business model implementation process
4. Automation system implementation process

We recorded the interview using a recording device and then transcribed it manually in order to extract the data for the result section.

4 Results

4.1 Drivers and motivation for implementation of PPO business model and automation system (see Table 1 and 2)

Both studied SME-companies explained that motivation to develop business models came from strategic needs to develop new sources for income. According to interviews, one major driver to the implementation of the PPO BM in both companies was the needed transparency to the real created value from their products to the customers.
In the starting phase company A had bigger technology limitation because of the very early start in 2001. For company B technological readiness was good because of complicated machine with high level AS. During the years Company A has integrated their knowhow into system very well.

4.2 Implementation process of PPO business model and automation system (see Table 1 and 2)

The results from interviews related specifically to the advantages and hindrances from company size perspective towards the different phases of the implementation process of PPO BM and automation system (AS) are shown in tables 1 and 2.

Company A mentioned that instead of intensive pre-study they started the implementation with experimenting with beta-customers. Company B started implementation fast from the idea to get new customers faster with PPO BM. In company B, AS system development towards PPO BM was not a big step, because the system was already equipped with extensive measurement and data collection system. Only limited modifications were needed to get a reliable AS for PPO based invoicing.

Table 1 describes the advantages and the disadvantages of being an SME that company A experienced to while implementing the PPO business model and the advanced automation system. As both companies are SMEs it was important to understand the whole value chain to create features supporting the implementation of the PPO BM with limited resources.

Table 1. SME related advantages and hindrances for company A from BM and AS point of view.

Company A	Advantages from the size (SME), PPO point of view	Hindrances from the company size (SME), PPO point of view	Advantages from the size (SME), AS point of view	Hindrances from the company size (SME), AS point of view

Initiation – analyzing the ecosystem	Motivation to find own niche BM to grow. Decision making process was fast and dynamic.	Harder to convince customer to use and buy novel BM based services. Limited resources for experimenting with customers.	Because of the limited resources team was forced to concentrate on relevant, focused tasks.	Not possible to collect data about customer needs extensively.
Ideation – generating new ideas		Limited resources to plan in advance, decision making more by gut-feeling. Not structured road map, more online planning.	Good customer knowhow about needs to fulfill requirements to engineer AS.	Resources were limited, not possible to explore and test many ideas.
Integration – building a new business model	Fast decision making. Goal was clear. Not too much internal resistance.	Had to accept customers which were willing for testing. Risk taking capacity was rather small	Goal was clear for everyone. Development team was motivated, small and had enough freedom to go on with internal decision making. No policy-limited decision making in supplier selection, need based selection.	
Implementation	Management was close and decision making towards new BM was fluent. Full commitment from the whole team.	Development steps were limited because of the resources, not possible to jump fast towards PPO.	Information flow between customer and supplier was better in small organization, better customer insight.	Limited resources, which had potential to slow down technology development towards to the technology required by PPO.

	Found own niche business area which was enough to fulfill SME size company needs.	Limitation to execute larger development projects fast, for example general IT data secure system.	Opportunity to sell also hardware to larger customers, which would not be possible without PPO implementation.	Sales forces and production capacity was limited.

Table 2 describes the experienced advantages and the disadvantages of being an SME that company B had while implementing the PPO business model and the advanced automation system.

Table 2. SME related advantages and hindrances for company B from BM and AS point of view

Company B	**Advantages from the size (SME), PPO point of view**	**Hindrances from the company size (SME), PPO point of view**	**Advantages from the size (SME), AS point of view**	**Hindrances from the company size (SME), AS point of view**
Initiation – analyzing the ecosystem	Decision making was agile. Company was forced to sell PPO BM solution instead of investment, because customers didn't believe performance level of the machine.	New way of doing business, because of small size and not well-known company was hard. PPO BM solved a problem.	Motivation of the team was excellent to develop a good system.	
Ideation – generating new ideas			Good customer knowhow to fulfill requirements of the AS.	Resources were limited, takes time to get system ready.
Integration – building a new business model	Big competitors didn't want to go to similar PPO	To convince customer in different places to believe PPO and measuring of the production,	Goal was clear for everyone.	Measurement of output was not easy. Took resources to realize

	model, because it was spoiling existing business structure. Fast decision making.	easier in Europe, harder in China and less developed countries.		measurement system.
Implementation	Readiness and capabilities to fulfill customer requirements. Possibility to use many selling channels and methods.	Biggest problem was financing the customer hardware when sold as a PPO BM.	Information flow between customer and supplier was better in small organization resulting better customer insight.	If the company wants to larger scope of supply with additional system components development resources were limited.

Both companies said that there was no internal resistance towards changes in BM. Both also stated that their organizations realized BM and AS development based on real customer needs. As we can see from table 1 company A mentioned that information flow between customer and supplier was experienced to be better in the small organization than larger ones, which was enabling better customer insight both for AS and BM purposes. Company A told that the low hierarchy of the company enabled fast decision making and reaction times. The experimenting phase gave good base for the BM and AS development.

Because of size and flat organization structure the companies had freedom to select most suitable AS according overall system requirement. Especially company A noticed that it was an important advantage when he compares their success to larger competitor who selected system according to internal rules instead of real AS system and PPO BM needs. In company B system was selected based on demanding machine control requirements and at the same it was serving PPO BM requirements very well.

Company A told that because of the low hierarchy of the company they were able do decisions and acts very fast. For that reason, experimenting phase gave fruitful results to the PPO BM and AS development. Same was true for company B, when they decided to implement PPO BM. Both companies agreed that AS technology development with connectivity (IIoT) development is important in enabling implementation of the PPO BM. In both companies at the moment data security issues cause concern in moving towards more open communication systems, for example cloud systems.

Concerning the AS, in company A I/O-quantity had increased 2-3 times from the beginning. Data was processed and collected in Physical product/Asset level [6] as well as Product/Asset cloud level [6]. Because of larger data collection and more advanced analysis also the calculation capacity of system was huge compared to the original system. They have basic technical readiness to use real cloud-based system, but because of the customer prejudices about IT-secure issue it is still marginal. Company B started automation system development with machine development and additional features

was added when they decided to have PPO BM. They have developed a full automation system to collect data from the Machine. I/O-quantity per system is 50-100 points. Current situation is that most of the systems are connected with 3G modem to company own server. User interface is playing major role in opening the critical information for the system operator to optimize the process and create saving or higher performance. Current system is very precise with measurement and enabling PPO invoicing.

Company B could also offer connectivity to customer systems with OPC-UA. inside own system, physical product/Asset level communication is realized with Modbus TCP and EtherCAT.

4.3 Interaction of PPO business model and AS

Very soon after starting the Company A noticed that the business model development and automation system development seemed to be strongly interdependent. Company A developed the first AS and in 2001 to collect data and optimize the production system. Connection to the machine was realized with a low capacity GSM network. But the main idea to create savings and optimize output with higher utilization level was already there. And the payment was indirectly connected to the achieved results. Because of the small company size the management was eager to see fast results and they were able to go fast for the first real experimenting and then later real PPO model.

In company B, the starting point of BM and AS development was much later in 2016, but the development speed towards PPO BM was fast. Customers, in many cases, were not ready to do the investment, so they decided to sell only output of system with PPO-contract. It speeded up sales, but at the same created a new bottle neck with the financing of the systems.

For Company B, from AS point of view, they had a very good starting point, because existing solution was already providing almost all features required to use machine with PPO BM.

4.4 Significance of PPO BM for companies' business

Pay-per-output (PPO) business model was experienced in the interviews as significantly important for the business of both the interviewed companies A and B in many ways, which were not only about the proportion of turnover from PPO to the whole turnover. As far as company A was concerned, the traditional business, where they sell the machine and later on in the lifecycle of the machine sell spare parts and components of the machine, was not enough to generate profits. Hence, company A implemented the PPO based optimization service. Company A explained that they carried out two things under the PPO based optimization business model: 1. Provided the machine with the optimization system to the customer and charge them under the PPO model. 2. Provided just the optimization system to the customer to run their existing machine (performing the same function as their own machine) and charged them under the PPO model.

Company B has a product which is unique when compared to the competitor's product but very expensive. Hence, company B designed a PPO model where the customer can use the entire product and related system and pay under the PPO model (i.e. pay as per the output of the machine and the related system). In the last couple of years, this has led to a situation where 20% of their overall business is now under PPO business model. Company B expects that it will be almost 100% of their business under the PPO model in near future.

PPO BMs output results in both companies were related with savings and process optimization to get more output. All value to generate savings or better performance was conveyed by automation system capabilities. That is why automation system played a major role in execution of the PPO BM successfully.

For both the companies, related to them being SMEs, PPO-model was experienced to provide a way to grow their business and compete in a business and market where there are many large companies. For company A the growth in the business was triggered because of the ability to manage machines that were manufactured by other manufacturers using their optimization system. For company B growth in the business was triggered because even if the machine they manufacture is expensive, under the PPO model the customer just pays for the output. This allowed them to tap into new customers and grow the business.

Through experimenting with the business model, both companies believed that output-based BM was leading to improved earnings in the long term.

5 Discussion and Conclusions

Both companies agreed that small size is both advantageous and brings limitations in the implementation process of BM. As for the advantages both companies due their small size they were able to recognize a new niche market, making use of the PPO BM, which were interesting and significant for their SME company, but probably would not have been interesting for larger companies. Second, internal small and flat organization of the SME was enabling fast adapting to the BM requirements. Due to the limited size both companies didn't have all needed expertise to implement PPO BM structured and preplanned way, for that reason they had to take relatively large risks in BM implementation.

Furthermore, company size seemed to matter in all phases of PPO implementation process: initiation, ideation, integration and implementation (See tables 1 and 2). The SME company size seemed also to impact in a manner that there was no clear roadmap and no before-planned separate implementation process phases in PPO implementation, e.g. initiation and implementation were very iterative and intertwined. Not all phases were very structured, especially integration was intertwined with implementation.

Both companies faced that small size is both advantageous and brings limitations in the implementation process of AS. Because of relatively small organization size and freedom from internal strict supplier policies, both companies were able to select most suitable advanced AS parameters according to the system requirement. Especially company A noticed that it was an important advantage when interviewee compares their

success to competitor who selected AS parameters because of internal rules instead of BM requirements.

Major strategic benefits from PPO BM were access to new markets, better profitability and overall growth opportunities. For both of these two SME companies PPO BM and advanced AS have given opportunities to succeed and differentiate their business from large competitors. In company A, open-minded BM and AS experimentation led them to a new business, relatively free from competition, and at least partly without precise planning, opened to them new markets to sell hardware, both as an investment product as well as a PPO service. In company B, PPO BM enabled the sales of a totally new type of expensive technology to customers which were not able to trust the promised performance of produced machine, sold in the form of an investment product.

In both companies there was clear interaction of BM and AS development. There was no internal resistance, for that reason both BM and AS development were really customer and system need based. Motivation to the PPO BM in both companies is transparency to real created value (saving or performance improvements). To enabled PPO BM AS has to full fill technical requirements for data collection, analysing and measurement and all that should be synchronized with BM. AS both are SMEs, they had internal pressure to get results of integration of BM and AS. That was the biggest reason that were forced to focus on customer requirements and try answer these requirements as good as possible to get commitment to continue.

Connectivity to different directions is extremely important for running PPO BM. Both companies have realized online connectivity to the machine. Current solution is point to point -type connection and it is not yet automatically integrated to the factory automation infrastructure. Security concerns and customer prejudice are still limiting larger cloud-based system implementation. But both companies are developing larger cloud-based system and believe that in future openness will grow.

This study contributed to the academic understanding of the implementation of advanced BMs, especially the very little studied PPO models, in the context of SMEs in particular.

This study brings forth some important managerial implications for manufacturing SMEs, especially those dealing with B2B capital goods. First, we demonstrate that PPO BMs are possible to be achieved also by SMEs, and that there can even be important small size-related benefits enabling SMEs to make use of such advanced PPO BMs that large companies cannot make use of. Among these are that the studied novel type of business models offer these SMEs new possibilities to compete with even larger companies that have e.g. the advantage of economies of scale compared to SMEs, by enabling SMEs for instance to enter interesting niche markets created by pay-per-output services and related BMs. Thus, they may position themselves into both new and existing markets in such ways that discourage or even prevent other companies, including larger companies, to enter the same markets. Such strategic benefits are enabled or facilitated by advanced automation and IIoT.

This study is limited by its approach to studying two case companies, and as such, it does not allow the direct generalization of results to other companies. The results and conclusions are important, however, already in this case study format, because there are very few studies that focus on SMEs in the field of advanced BMs (such as PPU

and PPO models) and advanced automation. It seems viable, however, to make the claim that also other SMEs will very probably find both similar types of benefits and also limitations in their attempts to make use of advanced business models like PPO models. Future research should attempt to include further SMEs, including different types of industries, to enable a more extensive generalization of the conclusions.

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PUBLICATION II

Rapid Sales Growth Mechanisms And Profitability For Investment Product Manufacturing SMEs Through Pay-Per-X Business Models

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17th IFIP International Conference on Product Lifecycle Management (PLM), Jul 2020, Rapperswil, Switzerland. pp.402-415, 10.1007/978-3-030-62807-9_32. hal-03753096.
https://inria.hal.science/hal-03753096v1

Rapid Sales Growth Mechanisms And Profitability For Investment Product Manufacturing SMEs Through Pay-Per-X Business Models

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Abstract. Manufacturing small and medium enterprises (SMEs) are recognized as a major driving force economically in the European Union (EU). However, manufacturing companies and SMEs have often met with major difficulties in digitalization, and more specifically, in the implementation of novel industrial internet-enabled business models, such as pay-per-X (PPX) type business. The overall aim of this study is to understand how manufacturing companies (especially SMEs) can make use of PPX business models largely in capital product markets, and how this impacts rapid sales growth and profitability for these investment product manufacturers. The studied two investment product manufacturing companies experienced rapid sales growth and there was an impact on the overall profitability for the companies. Sales growth was significant in both companies and PPX business models opened various new opportunities to extend company businesses. We found four main mechanisms that enabled rapid sales growth through PPX business models: strategic, pricing, financing and risk management mechanisms. Both the SME companies also experienced a negative impact on profitability despite rapid sales growth through PPX business models because of issues related to financing the investment product.

Keywords: Industrial internet of things, Industry 4.0, Business Models, Pay-Per-X, IIoT, IoT, Rapid Sales Growth, Profitability

1 Introduction

Manufacturing companies in general, and more specifically, manufacturing small and medium enterprises (SMEs) are recognized as a major driving force in European Union (EU) and elsewhere. However, manufacturing companies and SMEs have often met with major difficulties in digitalization, and more specifically, in the implementation of novel industrial internet-enabled business models, such as pay-per-output type business. It has been noted that manufacturing companies and especially SMEs (that have limited financial, technological and knowledge-related resources, and smaller tolerance towards risks derived from extensive business-related decisions, such as changes

and modifications in business models) struggle with the implementation of novel types of PPU services and related business. For instance, the tire manufacturer, Michelin, after having found that its high product quality and lifecycle cost advantages allowed a new competitive pricing model (pay-per-kilometer), the company reconfigured its sales competences to sell pay-per-kilometer services. However, it struggled for many years to become commercially successful. Michelin's pay-per-kilometer services became first successful, when it was able to implement technological novel possibilities to monitor the tire wear put, and to re-design its pay-per-kilometer services into a specialized PPU solution [1].

Even though in the above example, the company was a very large company, similar problems are common many PPU/PPX business model implementations, and they are common with manufacturing SMEs. While known that existing academic research concentrates almost solely on large companies in the topics of digitalization, Industrial Internet of Things (IIoT) and Industry 4.0 [2], the produced generic research or large-company-related research cannot be used as such by SMEs due to the special characteristics of SMEs [2, 3].

The actual strategic benefits of pay-per-X and especially pay-per-output type business models in manufacturing companies (especially in SME-companies) are very little studied and reported in academic literature. It is not yet properly understood how PPX BMs enable various strategic benefits, such as sales growth, and whether the BMs enable the created new business to be profitable, as well as how the investment product companies implement such advanced business models in such a manner that significant strategic benefits are achieved. Furthermore, it is possible that even if for instance the PPX models would allow sales growth, this sales growth might not be feasible in terms of sufficient profits and profitability. It is not yet properly understood in academic research which types of mechanisms related to the BM implementation help to create such feasible strategic benefits (here, especially sales growth and related profitability).

There are existing recent studies for instance on novel IIoT supported or enabled services and advanced non-ownership business models, including pay-per-use (PPU) and pay-per-performance (pay-per-output/outcome (PPO)) business models (BMs). However, existing studies very rarely consider the specific viewpoint of capital goods manufacturing companies or SMEs, and have provided practically no managerial implications to such companies (e.g. [4]). We aim to address this recognized research gap in this study by studying through detailed case studies manufacturing SMEs which have made use of PPX / PPO business models largely in their business. And in particular, in increasing rapid sales growth and profitability and seem to benefit from such BMs in various ways in investment product manufacturing.

The overall aim of this study is to understand how manufacturing companies (especially SMEs) can make use of PPX BMs largely in capital product markets, and how this impacts rapid sales growth and profitability for these investment product manufacturers. The main research questions are as follows:

1. How is the rapid sales growth achieved by PPX BMs for investment product equipment manufacturing SMEs?

2. How does the rapid sales growth enabled by PPX business models impact overall profitability for investment product equipment manufacturing SMEs?

The studied two investment product manufacturing companies can be considered as at least somewhat pioneering companies in their own investment product businesses, in making use of pay-per-output business models in the SME company category. The structure of this study is as follows: we first review existing research and the research gap in more detail. Second, we introduce the methodology of this paper, describe the cases and explain the questionnaire themes. Third, we present the results, and discuss them, leading finally into the conclusions and managerial implications.

2 Theoretical Background

2.1 Pay-Per-X Business Models

Non-ownership services can be defined as *services in which customers acquire some property rights to an asset and are offered a certain degree of freedom in using this asset for a specified period of time while the burdens of ownership remain with the supplier (owner)* [5]

The advanced nonownership types of business models can be divided into pay-per-use (PPU), pay-per-output and pay-per-outcome (both previous: PPO) models (the jointly so-called PPX business models). Pay-per-use model means that the customer pays for the use of the machine, and usually the other aspects related to the machine, i.e. ownership, installation, maintenance, upgradation, recycling is taken care of by the manufacturer. Pay-per-output models focus on the result of the machine use, which is normally demonstrated in monetary terms, and Pay-per-outcome models on the value derived by the customer after using the machine provided by the manufacturer.

It has been demonstrated in recent literature that advanced PPX business models are significantly enabled and facilitated by Industry 4.0 technologies, and e.g. [6–9] have studied the role of IoT technologies in PPX BMs.

2.2 Business Models And SMEs

Many studies have noted important differences between SMEs and large companies. For instance, [2] provide a good condensed description of major SME characteristics compared to large multinational enterprises: they sum up these characteristics to include 8 overall characteristic groups, including the following: finance, technical resource availability, product specialization, standards, organizational culture, employee participation, alliances and collaboration. Furthermore, various studies, e.g. [1] show that research on Industry 4.0/IIoT focuses strongly on large enterprises [16], and only marginally on SMEs [17].

There are studies that focus on servitization and advanced business models in manufacturing, which study the topic of service business and business models from the SME perspective[2, 3], and note the importance of business model studies specifically from SME perspective, due to the above various special characteristics of SMEs. Furthermore, some studies also take at least somewhat into consideration the context of capital goods / investment product sector while studying SMEs [4, 10].

Thus, we can draw the conclusion that business models, including advanced servitization business models such as PPX models, should be studied specifically from the perspective of SMEs for them to be useful, and furthermore, in addition to merely studying SMEs in this context (like some recent studies have done, e.g. [4]), the studies should also provide implications and guidelines for SMEs in particular.

2.3 Servitization, PPX models And Profitability In Manufacturing Companies

In overall, research shows that servitization in general has a positive impact on the performance of manufacturing companies, and furthermore, it increases manufacturing companies' profitability (e.g. [11]). However, while some rather recently popularized services like advanced Pay-per-X type of services may have a positive impact on companies' profitability, it has been noted in literature that there can also be risks in the PPX implementation that require novel capabilities from companies, and may negatively impact profitability unless the implementation is planned carefully (e.g. [12]). Thus, the topic of profitability should be considered when studying the feasibility of advanced BMs, such as PPX models.

2.4 PPX Business Models And Their Strategic Impacts In Manufacturing Companies

There are a few studies which have relatively recently addressed the topic of PPX business model uses in the B2B and partly also in more detail in the investment product sector [4, 13]. They found, in general, first, that in this context, companies have been able to receive important strategic benefits from PPX services. The main focal point of these studies were specifically PPU services, not so much the PPO services and business models, which have been very little studied in the investment product sector companies, and which are focused on in our study. These found benefits were related to three distinct strategic objectives: rapid sales growth, market share expansion, and new market creation. They also found that PPU models accelerated market penetration and impacted rapid sales growth often in the early lifecycle phases of industries, and with relatively novel technologies, such as solar and wind power industries. Also other benefits have been found, including more steady and predictable cash flows, sustainability in terms of both environment and business, etc. [4, 14, 15]

We identified several major mechanisms from recent literature [4, 16] to reflect impacts to the rapid sales growth with PPX BMs in manufacturing companies. Some of the commonly addressed ones were related to sales strategy, pricing, financing, and risk

management mechanisms. Sales strategy impacts sales growth, because customers do not necessarily evaluate lifecycle costs and companies are losing business to competitors, which are less expensive in short term, but more expensive in long term. A well-known basic intrinsic advantage of PPU is that it can be offered to customers who do not desire a large number of uses of the product. Another advantage of the PPU lies in the firm's exibility toward incomplete information about customers' usage needs: if the usage quantities are imperfectly known to the firm beforehand, the seller needs to hedge in its pricing against this uncertainty in usage. One more advantage of the PPU business model stems from the ability to vary the “level of service" by making the product more or less available to the consumers. Varying services affect the customer's benefit but also the service total costs [16].

However, there are also potential risks and downsides noticed from PPX/PPU services: for instance, companies have to cope with the threat that amortizing product costs can take longer through PPU revenues, compared to selling the product directly, and furthermore, the uncertainty about maintenance costs can impact the profitability of PPU services (see [12]).

Thus, we find that there should be more research to better understand the strategic benefits of PPX in the specific context of B2B companies and especially the manufacturing investment product sector companies, also considering the important aspect of profitability of PPX models, and the generic mechanisms behind the strategic benefits and profitability from PPX BMs.

2.5 PPX Business Models And Profitability

There are various existing studies that address PPX pricing and business models in the context of software products. For instance, [17] study the profitability of adopting PPU for a digital good, compared with a fixed-price one-time purchase business model. However, there are limitations in making use of software-related PPX research in manufactured products, especially in the context of investment products and project business/manufacture-to-order products, because of huge differences in production and logistics costs, as well as the related scalability of earnings and the business model to a large quantity of customers. [12] found that regarding PPU profits, uncertainty about a product’s maintenance costs can threaten the profitability of PPU services. [16] present a model explaining why PPU business models have become profitable alternatives to traditional selling models across a wide range of goods. In more detail, they identify three situations where a PPU BM can be more profitable than selling: first, when the logistics costs of goods are not too high (new technologies such as Industry 4.0 have been found to reduce logistics costs, making the PPU models more profitable); second, when companies have little information about customer usage profiles, PPU's effective pricing that takes into consideration customers' varying usage offers an advantage over selling; and third, when service providers can vary their service level (in the form of the good's availability), they further increase their advantage because they attract even

the high usage consumers. In such a case, the PPU model performs more profitably even for higher levels of logistics costs.

2.6 Research Gaps Addressed By This Study

In overall, there are very few studies that aim to understand the role of PPX, especially the little studied PPO business models in investment product sector companies, which differ significantly in many respects from the much studied PPX services and BMs in the software sector, as well as the relatively much studied PPX in the consumer mass product sector. The latter ones (PPX in software and mass consumer product industries) differ significantly from investment products in the respect of e.g. the economies of scale that can be made well use of in their PPX business models, as well as considering the very different supplier risk profile compared to the investment/make-to-order products, that this study concentrates on.

We have found no detailed case studies on the mechanisms behind sales growth and profitability in the context of PPX models in SMEs and investment products; we have recognized few more overall multi-company case studies studying PPU BMs (e.g. [4]), which do address PPU business models from the perspective of strategic objectives, but they do not study specifically PPO BM's, like we do in this study, and they do not go into very much detail behind sales growth and profitability mechanisms, and in particular, current studies that exist have not provided implications specifically to SMEs like our study aims to do.

Furthermore, to our best knowledge, our study is also the first or at least among the very first to consider SME company size in somewhat more depth while studying the strategic objectives of PPX business models, and particularly so in understanding the strategic opportunities of PPX BMs in manufacturing SMEs in the specific context of investment product manufacturing companies.

3 Methodology

The aim of this research is to understand how SME companies can make use of PPX business models largely in investment product markets, and how these impact rapid sales growth and profitability for the investment product manufacturers. To study this, we have used case study methodology, by selecting pioneering SME investment product manufacturing companies that have been doing business using the PPX business model for few years. In order to answer the research questions appropriately, we designed a selection criterion, under which we selected companies that were investment product manufacturing SMEs, pioneering in their business, B2B businesses, companies that had already implemented PPX business models.

Based on the above selection criteria, we selected two companies, Company A and Company B based in Europe. Both the companies make complex machines equipped

with Industry 4.0 based technologies. We have signed a confidentiality agreement with the companies, that does not allow us to mention their names and details of their businesses. On a broader level, they are B2B investment product manufacturing SMEs, pioneering in their business and have implemented the PPX business models with many of their customers.

Company A:

Company A manufactures investment products and have been using a variety of PPX business models to sell the investment product to their customers, who in turn use the investment product to manufacture the end-product. Company A has been selling the machines under PPX business models for the last 3 years and approximately 40% of their business comes from PPX business models. Company A works with a third party that buys the machine as assets from Company A and Company A is able to provide the same machine via PPX contract to the end customer. This way Company A offloads the ownership of the asset to the third party. Because of the non-disclosure agreement between the researchers and the Company A, we cannot provide more details about the third party.

The various PPX business models Company A uses are as follows:

1. pay per availability – customer pays for the uptime
2. pay per output (with a minimum payment threshold) – customer pays for the output that the investment product generates. As per the agreement, the customer agrees to pay a minimum per month irrespective of the output.
3. pay per savings (investment part paid partly) – This is a PPX business model which is not implemented but very close towards implementation. The logic of this business model is that the customer pays partly for the product and both the customer and the manufacturer agree to share the savings created by the use of the product.
4. extended warranty – This is more of a "Hybrid" PPX business model. The earning logic behind this business model is of the hybrid nature, as in, the customer pays a reduced price for the investment product and purchases regular maintenance contract where the manufacturer guarantees the performance and any savings made because of the machine's usage will be shared between the manufacturer and the customer.

Company B:

Company B manufactures investment products and via distributor sells it to the customers (B2B) using PPX business models. The PPX business model contracts are made and controlled by the distributors. Hence, the distributors act as the third party between the manufacturer and the end customer, as far as the PPX business models are concerned. Company B's distributors have been selling Company B's machines via PPX contracts for the last 2 years. The distributors are selling Company B's machines under the pay-per-output PPX business model to the end customer. Company B guarantees the performance of the machine to the distributor in order to make sure the PPX business model contracts are successful. Approximately 15% of their business comes from the above arrangement with the distributor via PPX business models.

We conducted a qualitative interview session with both the companies that lasted for about 2 hours each. In both Company A and Company B we interviewed senior vice presidents, who understood the strategy behind PPX business models for their respective companies in detail. As there is lack of space, we are not able to attach the entire interview questionnaire, but we will describe the major interview themes in the following paragraph. We designed a semi-structured questionnaire with a few open questions and some specific structured questions. All the questions are categorized under the following categories:

1. Background questions
2. Questions about strategic objectives towards PPX business models from rapid sales growth point of view
3. Impact of PPX business models enabled rapid sales growth on the overall profitability
4. SME related opportunities and limitations that impact the rapid sales growth because of PPX business models.

We recorded the interview using a recording device and then transcribed it manually in order to extract the data for the result section.

4 Results And Findings

1. Rapid sales growth because of the PPX business models

Both companies stated that the PPX business models are very important for the rapid sales growth. They have grown during last two years significantly because of PPX business models.

Company A stated,

"We started implementation in 2017 and last year (2019) 35-40 % of produced machine are sold via PPX business models."

Company B stated,

"For us, more than half of the growth, in the last two years is attributed to PPX business models via distributors. We have doubled our turnover during last two years because we are able to sell more machines through the PPX business model contracts."

2. Rapid sales growth PPX BMs, mechanisms

Rapid sales growth has come through different mechanisms. We identified four different mechanisms from interview data: strategic, pricing, financing and risk management mechanisms. According to our results gaining new customers and extending business with existing customers were important for the sales strategy mechanism. Pricing mechanism sets the balance between sales growth and profitability. Partnering with financial institutes is essential to get enough financial resources for growth, and PPU BM is impacted by risks related to sales growth and profitability. Research results showed that financing was experienced as important in PPX BM implementation. Interviewed companies emphasized risk management's important role when implementing PPX BMs.

Table 1. Mechanisms for rapid sales growth by PPX business models.

Factors impacting Rapid Sales Growth	*Company A*	*Company B*
Strategic mechanisms	- PPX business models allowed selling to new customers, who found the machine very expensive otherwise. - Reason for high price is better technology, which leads to the significant lower operation costs. -Absolute turnover depends on the contract type, where, capital can be in company A's own balance sheet, 3rd party's balance sheet or end customer's balance sheet or all combinations.	- Machines are sold to the distributors who in turn sell it to the end-customer by PPX business models. - Threshold to order reduces. – Reduction in investment cost for the distributors if they buy fleets. - Increase in the maintenance contract to accommodate PPX related issues. - Dynamic business for the end-customer, hence, PPX provides required capacity to them via the distributor.
Pricing mechanisms	High cost of machine limits the sales, but PPX business models allow flexible pricing reducing the customer's threshold for purchase.	Company B reduced the investment cost for the distributors and increased the service contract (to accommodate PPX). This allowed the distributor to sell the machines as PPX contracts.
Financing mechanisms	Usage of third part financing is enabling PPX BM. But it is also limiting and capturing part of the profit.	Current system allows the distributor to extract maximum benefits of PPX contracts.
Risk management mechanisms	For both the companies, their customers can change the machine supplier, because of PPX business models in case of unforeseen circumstances (such as bankruptcy for company A and B)	

Table 1. above describes the mechanisms that enable rapid sales growth by PPX business models. Both the companies have described the mechanisms under the factors of strategy, pricing, financing the product and risk management.

3. Impact of PPX business models on overall profitability of the companies

For company A PPX business models related rapid sales growth start impacting the profitability of the company once the cost of manufacturing the machine is amortized. The machine manufactured by Company A is complex and uses novel technologies, which makes it high-end and expensive, resulting into a negative impact on profitability via traditional selling based business model, whereas, PPX contracts guarantee additional profits based on the X (i.e. use, output or outcome of the machine).

Company A stated,
"In short term profitability is not impacted much, but in long term when the fleet is massive and bigger part of the investment is amortized then profits are prominent."

Company A internally calculated that the investment amortization time is much shorter than expected lifetime of the machine. Moreover, they are also earning during amortization time after paying the financing cost to the third-party company. In company A amortization time is about seven years, but because the product operation cost is very low compared to the competitors, they were able to set a relatively better (and higher) PPX business model contract price. Hence the cumulative profit accrual during the machine lifetime is much higher than if the machine was sold under the traditional selling-based business model.

For company B, the presence of distributors dilutes the additional profits to some extent, but overall profitability is positively impacted because of increased sales (by reducing investment cost) and higher service contracts.
Company B stated,
"As of now we share the profits of PPX business models with the distributor, but it would be ideal if we can keep the ownership of the machines and customers pay using the PPX business models, without the distributor presence"

4. Size (SME) impact to the implementation of PPX BM
Company A saw size of the company (SME) as an advantage in a manner that they can be flexible and fulfil customers specific and customized requirements without much of an internal resistance. PPX business models allow them to approach and sell the machines to bigger customers based on the X (use, output or outcome) even if the cost of the machine is high.
Company B stated,
"Because we are SME, hence there is an advantage from low hierarchy, fast decision making, and capabilities to modify contract according to customers' requirements (resulting into more deals)."
Both stated that significant disadvantage is that in overall, financing needs of PPX model limit the PPX BM implementation and growth, which also resulted into involving various third parties (financing the machines, distributors).

5 Discussion And Conclusions

We will next draw major conclusions on the basis of our results, and thus aim to answer to our main research questions.

Responding to RQ1 (How is the rapid sales growth achieved by PPX BMs for investment product equipment manufacturing SMEs?). On basis of the results we find that the sales growth of both the studied companies could be significantly impacted because of PPX business models. Investment product manufacturing companies that manufacture high-end machines from the technological perspective (Industry 4.0 technologies) do not usually achieve rapid sales growth through traditional selling-based business model because of a high threshold to buy from the customers. PPX business models

seemed to lower the threshold significantly by allowing the customers to pay for the use, output or the outcome instead of the machine itself. This resulted in rapid sales growth for these kind of manufacturing companies.

We can infer that there were several different types of important mechanisms, described in more detail in Table 1 of section 4 (Results and findings), which enabled or facilitated the rapid sales growth in the studied SMEs. In overall, these mechanisms were related to pricing, financing, risk management and strategic sales decisions as mentioned in Table 1. For larger customer companies, trust (in terms of reliability and performance of the machine) is often a major roadblock while buying expensive high-end machines from SMEs such as company A and company B. PPX business models were found to lower this threshold to buy and to allow the customer to experience the performance as well as the reliability that the machine offers, without a significant risk. Customers were able to get these machines to their respective factories via PPX contracts and pay for the result or performance of the machine. This, in turn, introduced a major risk for the manufacturing companies in terms of capital, while somebody has to bear the cost of manufacturing the machine. Both the case companies were found to have created interesting approaches to mitigate the risks related to capital in PPX model implementation. Company A did this by selling the machines to a third party that provided the needed capital and allowed company A to sell the machine to the end-customer through PPX business models. Company B, in turn, sold the machine to a distributor (also a third-party in this case) and the distributor sold the machines to the end-customers via PPX business models. This eventually led to rapid sales growth for both the companies. PPX business models also lowered the risk for the customers in case of unforeseen circumstances such as bankruptcy of the SME manufacturing companies, which had only a limited capability to carry such risks by themselves, due to their relatively small size and own resources. Customers were able to change the supplier of the machine by terminating the PPX contract and thus, they did not have the burden of a non-performing asset in their company. These mechanisms together led to rapid sales growth for the SME case companies (company A and company B).

Responding to RQ2 (How does the rapid sales growth enabled by PPX business models impact overall profitability for investment product equipment manufacturing SMEs?). We can infer that the studied companies were able to make use of PPX models for rapid sales growth, the PPX models ultimately impacting positively the overall profitability. Results related to the overall profitability clearly demonstrate that because of the different mechanisms for rapid sales growth, the positive impact on profitability was different for both companies. For company A, they saw an immediate impact on their profitability even during the amortization time, after paying of the agreed sum to the third party. More importantly, they estimated that this positive impact on profitability will be grow exponentially once the amortization period is done. For company B, the impact on profitability was also positive but rather limitedly so, because of the distributors. It was essential for them to work towards a situation where they could replace the distributor with a financing third party like company A, and thus start getting a bigger share on profits from PPX business model implementation. In general, rapid

sales growth enabled by PPX business model did impact positively the overall profitability of the companies, but there were other factors, such as third parties, that had their at least temporarily limiting impact to the profitability.

We also found that the small SME size and related limited resources (financial, technological and expertise- related) seemed to impact clearly many of the studied decisions and mechanisms in both the SME companies, which were related to the strategically beneficial and profitable implementation of PPX BMs. SME size advantages such as faster decision making, and flexibility seemed to allow the companies to provide customized solutions to the end-customers making the PPX business model even more attractive for the customers. On the other side, financing the equipment under the PPX business model was a major SME size related downside for both companies. Both the companies dealt with the issue of financing via the third-party mechanism, either engaging with a third party that bought the equipment as an asset and let the company (company A in this case) to figure out the PPX contract terms, or by selling the equipment (and an extensive service contract) as a fleet to the distributor, who in turn sold the equipment to the end-customer via PPX business models. The need for involving such third parties, again, seemed to decrease the profitability of PPX at least in the short term.

Academic contribution. This study contributed to the academic understanding of the major strategic benefits of advanced BMs, especially the very little studied PPX models, through increasing the understanding of the generic mechanisms behind the rapid sales growth in especially in manufacturing companies that produce investment products for the use of other companies in their production processes, which has been studied earlier e.g. in ([4]). We add especially by analyzing in more detail a) some major mechanisms towards sales growth in particular, and b) mechanisms behind the profitability of PPX business model implementation. Some interesting recognized and analyzed ones here are related to the varied use of third parties that provide additional resources (expertise, financing, networks and contacts) to studied SMEs, which cannot find it not feasible to acquire such resources feasibly by themselves.

Furthermore, we add the academic understanding of the strategic benefits realization (especially rapid sales growth and related profitability) of PPX business models, in the context of investment product companies and SMEs in particular. Earlier studies have not provided implications especially to SMEs in this context. We have demonstrated that the SME perspective mattered significantly in studied SMEs e.g. in the manner of the third part involvement, faster decision making as well as flexibility to provide best suited PPX business model contracts to the end customer.

Managerial implications. Managers of the investment product manufacturing SMEs should take into consideration various strategic objectives especially rapid sales growth while implementing PPX models. The cases in this paper have demonstrated various mechanisms that can enable rapid sales growth through PPX business models. It is important that the managers take into account these mechanisms in order to successfully implement PPX BMs, and achieve rapid sales growth through them. One of the key outcomes for strategic objectives is to impact profitability and both the studied cases demonstrate what the managers should take into account while strategizing profitability impacts via rapid sales growth enabled by PPX business models. Managers of SMEs

should think about the role of third parties from the financing perspective in order to achieve rapid sales growth and create an immediate impact on profitability.

Limitations of the study. The conclusions are somewhat limited by this study's approach to studying two case companies, and as such, it does not allow the direct generalization of results to other companies. The results and conclusions are important, however, already in this case study format because there are very few studies that focus on SMEs in the field of advanced BMs (such as PPX business models) and industry 4.0. It seems viable, however, to make the claim that also other SMEs will very probably find both similar types of strategic benefits and related mechanisms viable and useful in their attempts to make use of advanced business models like PPX model.

Future studies can explore in more depth the role of third parties to achieve rapid sales growth and eventually impact profitability through PPX business models, especially for SMEs. This paper presented rapid sales growth mechanisms through PPX business models from SME perspective. Future studies can compare the mechanisms for SMEs and larger companies and identify similarities as well as differences in the mechanisms. One of the objectives of this paper is to study the impact on profitability through rapid sales growth enabled by PPX business models. Future studies can take into account other strategic objectives presented by [4], such as market share expansion and new market creation and study their impact on profitability from investment product SME manufacturing companies. Future studies can focus on pricing of the PPX business model contracts and analyze the impact of pricing on overall profitability.

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PUBLICATION III

Morphological Analysis for Designing and Configuring Outcome-based Contracts for Machine Manufacturers: An Empirically Grounded Conceptualization.

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Submitted to Journal of Enterprise Information Management, 2025

PUBLICATION VI

Challenges, Mitigation and Benefits of Outcome-based Contracts in Small and Medium-sized Machine Manufacturers: A Qualitative Exploratory Study

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International Journal of Mathematical, Engineering and Management Sciences. 8, 1149–1170. 2023.
https://doi.org/10.33889/IJMEMS.2023.8.6.065

International Journal of Mathematical, Engineering and Management Sciences
Vol. 8, No. 6, 1149-1170, 2023
https://doi.org/10.33889/IJMEMS.2023.8.6.065

Challenges, Mitigation and Benefits of Outcome-based Contracts in Small and Medium-sized Machine Manufacturers: A Qualitative Exploratory Study

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(Received on June 18, 2023; Accepted on September 5, 2023)

Abstract
Outcome-based contracts (OBCs) offer machine outcomes while maintaining machine ownership with the manufacturer. To this end, the scientific literature lacks systematic studies on sharing insights from the perspective of small and medium-sized enterprise (SME) machine manufacturers (MMs) while implementing OBCs. We interviewed four SME MMs that have successfully offered OBCs. Further, we use exploratory multiple-qualitative case study research. We identified that SME MMs face various challenges, such as ownership of expensive machines, the long payback period of OBCs, protection of IP, the need for constant innovation, and delivering the required performance while offering OBCs. Further, we identified that SME MMs have identified ways to mitigate these challenges, such as involving third parties to own the machine and ensuring earnings by including separate contracts for other activities such as installation, maintenance, training of the employees working on machines, and logistics, to overcome the challenge of the long payback period of OBCs. Additionally, we identified various SME MM-related benefits from OBCs, such as entering competitive markets, optimizing the cost of operating the machine, novel efficient ways of selling and marketing machines, avoiding money laundering and legal issues, and reducing investment through recycling the machine and its components that SME MMs have while offering OBCs. We share insights into how SME MMs offer OBCs, which typically involve significant risks, by empirically studying the challenges, mitigation of challenges, and benefits of offering OBCs.

Keywords- Product-service systems, Outcome-based contracts, Servitization, Small and medium-sized enterprises, Manufacturing.

1. Introduction

Manufacturing enterprises that were previously selling only their machines have now started to offer outcomes with the help of outcome-based contracts (OBCs) (Schaefers et al., 2021). In OBCs, this outcome is in the form of the hours of machine availability, output units produced from the machine, and the savings/ economy created by the OBCs (Böhm et al., 2016; Grubic and Jennions, 2018; Korkeamäki et al., 2022;

Neely and West, 2022; Lin et al., 2023; Shanmugam and Dhingra, 2023). Offering OBCs has many advantages from the perspective of manufacturing enterprises, such as becoming loyal suppliers (Baines et al., 2007), enhancing business knowledge (Solima et al., 2016), and having positive environmental impacts (Tukker, 2015). In the current study, we plan to understand what challenges and benefits small and medium-sized enterprises (SME) and machine manufacturers (MMs) have while offering OBCs.

The current scientific literature focuses on how large manufacturing enterprises offer OBCs. For example, there are articles that deploy the Business Model Canvas (BMC) to make decisions on items such as the value proposition, key partners, key activities, key resources, and customer segments while offering OBCs or designing the transition towards offering OBCs (Barquet et al., 2013; Adrodegari et al., 2017; de Olivera et al., 2018). Similarly, there are articles focusing on the importance of IoT and digitalization technologies while delivering OBCs (Grubic and Peppard, 2016; Rymaszewska et al., 2017; Paiola and Gebauer, 2020). Moreover, there are articles that study the operational practices (Korkeamäki et al., 2022; Baines and Lightfoot, 2013) and competencies (Rabetino et al., 2017; Gebauer et al., 2017; Visnjic et al., 2018) that support the delivery of OBCs. However, the challenges faced by organizations while offering OBCs and the mitigation of those challenges are not discussed. For example, when it comes to the ownership of the equipment, scientific literature suggests that the equipment is owned by MMs (Barquet et al., 2013; Adrodegari et al., 2017; Gebauer et al., 2017). However, for SME MMs, it would be a challenge to own the expensive machines during the initial phase and when the machines are not performing. For SME MMs to be successful while offering OBCs, it is critical to identify such challenges and various ways to mitigate them.

Extant literature has focused on large enterprises. Insights from large enterprises cannot be applied to SMEs, as SMEs have different resources, opportunities, and needs. For example, large enterprises have more financial resources (Mittal et al., 2018; Müller et al., 2018), and they have multiple businesses that run in parallel to ensure earnings. Likewise, the financial resources available to large enterprises support them in sustaining long payback periods in OBCs. On the other hand, SME MMs are typically highly specialized. As a result, the SME MMs are dependent on a single source of revenue, and for them to offer OBCs, it is complicated. Similarly, successful large enterprises have developed separate service units to offer OBCs (Lenka et al., 2018). However, adding a separate service organization will add complexity to the structures of SME MMs, creating high coordination costs and limiting flexibility. To generate returns, time is needed, and there will be a dead valley before OBC earnings reach investment-based model earnings.

Existing studies in the scientific literature do not share insights from SMEs that have successfully offered OBCs. There are studies (Zancul et al., 2016; Dahmani et al., 2020; Low et al., 2022) that consider the SME MMs' perspective while offering maintenance, renting, and leasing contracts. Similarly, servitization has been considered a competitive strategy for SMEs. As a result, frameworks and maturity models (Kowalkowski et al., 2013; Adrodegari et al., 2017; Adrodegari and Saccani, 2020; Kolagar et al., 2022) focusing on the design of servitization business models (BMs) have been proposed. Additionally, the capabilities and technologies required by SME MMs for servitization have also been proposed (Gebauer et al., 2012; Kanninen et al., 2017; Schroeder et al., 2020). Nevertheless, none of these studies focuses on identifying the challenges and benefits that SME MMs have while offering OBCs. Overall, the scientific literature presents only one case of a SME MM offering product-service systems (Adrodegari et al., 2017). The overview of challenges identified in this study (Adrodegari et al., 2017) is related to changes in customer conditions and service personnel and the estimation of cost calculations, and it was suggested that these risks can be mitigated by the length of the contract and a customer being penalized for changing the contract conditions. Similarly, the benefits of offering OBCs are related to the prediction of machine failure.

Overall, insights into SMEs specifically offering OBCs have not been discussed. In conclusion, this study addressed the following three main research questions:

RQ1: What are the critical challenges faced by small and medium-sized machine manufacturers when offering outcome-based contracts?
RQ2: How are the identified challenges mitigated by small and medium-sized machine manufacturers when offering outcome-based contracts?
RQ3: What are the benefits for small and medium-sized machine manufacturers when offering outcome-based contracts?

We provide insights into how SME MMs can successfully offer OBCs. Our insights are based on findings from four SME MMs that have successfully implemented OBCs. These insights were identified using an exploratory qualitative multiple-case study method. We investigate B2B MMs that are unique because they are involved in the manufacturing of sophisticated machines and face complications related to resource heterogeneity, adoption of technologies, and communication with stakeholders. Furthermore, SME MMs are even more interesting to study because they face challenges related to SMEs, B2B manufacturing enterprises, and the delivery of outcome-based contracts.

The remainder of this paper is organized as follows: section 2 presents the theoretical background of this study. section 3 describes the research methodology we followed in the study. In section 4, we present the results of our study and discuss the results in section 5. Finally, section 6 presents the conclusions, theoretical and managerial implications, limitations, and future research directions of our study.

2. Theoretical Background

According to the European Union, SMEs are defined as enterprises with fewer than 250 employees, an annual turnover of 50 million euros or less, or an annual balance sheet of less than EUR 43 million. SMEs have huge significance in the EU economy. For example, in Germany, SMEs account for up to 99.6 percent of enterprises, 59.4 percent of employees, and 35.9 percent of annual turnover (German Federal Ministry of Economic Affairs and Energy, 2014). However, despite the significance of SMEs, overall research on SMEs remains rare (Müller et al., 2018; Mittal et al., 2018).

2.1 Small and Medium-Sized Machine Manufacturers

Mittal et al. (2018) provide an illustrative and condensed description of manufacturing SMEs' main characteristics compared to large enterprises: these characteristics sum up to include eight overall clusters of characteristics. These include finance, technical resource availability, product specialization, standards, organizational culture, employee participation, alliances, and collaboration. Furthermore, SME MMs are often the suppliers of components and subsystems to larger companies. Thus, SME MMs experience difficulties moving downstream in the value chain because of potential competition with their larger customers, distributors, and installers (Gebauer et al., 2010).

Furthermore, the implementation of OBCs centrally deals with new ways of sharing risks and benefits. However, SME MMs lack resources, expertise, and risk-taking capability due to their small size compared to large companies (Müller et al., 2018). On the contrary, SME MMs might simultaneously benefit from their relative flexibility and potentially faster decision-making capability (Mittal et al., 2018) while offering OBCs. To sum up, SME MMs are truly different from larger companies in many important respects, and these differences make it difficult for SME MMs to directly use studies regarding BMs and new services that have been made in the context of large enterprises.

2.2 Servitization and Outcome-based Contracts

Servitization involves offering product-oriented, use-oriented, and result-oriented BMs (Tukker, 2004). Product-oriented, use-oriented, and result-oriented BMs are also referred to as product-service systems (Tukker, 2004). Product-oriented BMs cater to investment-based models, where the machine is owned by the customer and the customer pays for the additional services such as maintenance of the machine. Use-oriented BMs cater to renting and leasing services, where the machine is owned by the manufacturer and the customer pays for using the machine. Finally, there are result-oriented BMs, where ownership of the machine belongs to the manufacturer and the customer pays for the results, or outcomes, delivered by the machine. Result-oriented BMs are also referred to as performance-based contracts (Hypko et al., 2010b; Liinamaa et al., 2016) and outcome-based contracts (Grubic and Jennions, 2018).

Result-oriented BMs are further categorized as activity management/outsourcing services, pay-per-service units, and functional results (Tukker, 2004). In the pay-per-service unit, the customer pays for the time units (or the number of hours the machine is deployed for) and the number of output units produced by the machine. More recent studies have used the terms pay-per-use (Gebauer et al., 2017; Uski et al., 2022) and availability OBC (Böhm et al., 2016; Grubic and Jennions, 2018; Korkeamäki, 2021) when the customer pays for time units. For example, the number of hours a tractor is used to extract fruits and vegetables from the field. Whereas output OBC (Korkeamäki, 2021) and pay-per-output (Uski et al., 2022) are the terms used to denote the output units produced. For example, the number of copies photocopied using a photocopier machine. Finally, functional results consider the amount of added value (e.g., energy savings) that the provider brings from the customer's perspective. For example, the units of energy saved while using a generator are offered in OBC. Recent literature has used the terms economic OBC (Uski et al., 2022) and pay-per-outcome to denote functional results (Böhm et al., 2016; Grubic and Jennions, 2018; Korkeamäki, 2021).

In this study, we use OBCs to denote similar BMs and services. Furthermore, we categorize OBCs into availability, output, and economic OBCs. In scientific literature, OBCs are quite often referred to as BMs (Ng et al., 2009; Grubic and Jennions, 2018), even though related studies do cover some but not all the major aspects of a BM. For instance, considering BMC components, only the value proposition is usually covered by OBC-related studies, whereas aspects like cost structure, key partners, and customer segments are not usually covered.

2.3 Servitization in Small and Medium-Sized Machine Manufacturers

Only a few academic studies (Kowalkowski et al., 2013; Adrodegari and Saccani, 2020; Kolagar et al., 2022) address servitization from the SME perspective. Bhamra et al. (2018), noting the specific needs of SMEs for service and business model development, argue that customized information is required to implement product-service systems in SMEs. Overall, existing research on service models largely neglects how company size affects service development (Gebauer et al., 2020). For instance, Oliva and Kallenberg (2003) argue that companies must enter the service market by serving an installed base. However, SMEs often sell through distributors, deliver through installers, and have limited access to their installed bases.

2.4 Unique Challenges Faced by Small and Medium-Sized Machine Manufacturers

To our knowledge, the current scientific literature offers only one study (Adrodegari et al., 2017), focusing on the challenges faced by a Finnish SME MM while offering OBCs. These challenges were related to changes in customer conditions and service personnel, cost estimations, and customer interest in carrying the OBCs. Adrodegari et al. (2017) also suggested that these challenges were mitigated by penalizing customers for changing the initial contract conditions. Similarly, predicting failures was suggested as a benefit of SME MMs while offering OBCs (Adrodegari et al., 2017). However, the study (Adrodegari et

al., 2017) only presented a single case study focusing on SMEs offering economic OBCs only. The present study performed an in-depth qualitative analysis of four diverse SME MMs to share their challenges and the benefits that they faced during the successful implementation of OBCs.

3. Methodology

The scientific literature lacks studies on how manufacturing enterprises can design OBCs (Adrodegari et al., 2018; Bains and Lightfoot, 2014), and we did not find any studies focusing on the design of OBCs from the perspective of SMEs. Therefore, we selected a qualitative multiple-case study research method, an inductive research approach, as the way to deal with a topic requiring exploratory research (Meredith, 1998; Yin, 2003). Moreover, our research: i) focuses on a contemporary real-life topic; ii) consists of how and what research questions were asked; and iii) we, as researchers, did not have any control over the events that accompanied our research questions.

Case Selection: Since the objectives of our research and the exploratory nature of our empirical settings followed theoretical conceptualization based on non-probability sampling techniques rather than a statistical sampling logic, we employed a theoretical sampling approach (Gentles et al., 2015) to select different types of SME MMs. Furthermore, the convenience and accessibility of the company representatives also played an important role in identifying the companies (Mason, 2010). Therefore, our focus was to select companies that could depict a variety of situations and challenges faced when SME MMs offer OBCs. Moreover, we selected companies based on the following inclusion criteria: First, we selected SME MMs dealing in the B2B domain. Second, we selected companies that have implemented their OBCs for more than two years to ensure that the outcomes and benefits of OBCs are more evident.

We started identifying the companies by searching on Google for the SME MMs that have successfully offered OBCs. We shortlisted such companies by going through studies, websites, and reports available on Google to understand what kind of OBC these companies offered. Furthermore, we identified OBCs based on their definitions (see section 2.2). Finally, we invited people at the senior management level (e.g., director and CEO) of these shortlisted companies to participate in our research, and finally, representatives of four SME MMs agreed to participate.

Our four SME MMs were selected to be diverse in various important OBC-related aspects (see Table 1) based on: i) the type of enterprises, for example, machinery and equipment manufacturing, metal product manufacturing, and electronics inspection; ii) the type of OBCs they offered, for example, availability OBC, output OBC, and a hybrid of availability OBC and economic OBC; iii) primary function of the machine offered during OBCs, for example, producing industrial gases and metals, and inspecting electronics hardware and software; iv) the machine offered by companies was standardized, or both standardized and customized; and v) the machine criticality (highly critical vs. less critical) to the customer's operations.

Data Collection: Since the research questions of our study have so far been unexplored and our questions required follow-up queries, we used semi-structured interviews to collect data (Adams et al., 2015). We started with developing a list of broad interview questions to evoke insights regarding how the MMs make important decisions when it comes to offering OBCs. As identified in the previous studies (Lay et al., 2009; Hypko et al., 2010a), these decisions focus on aspects concerning ownership of assets involved in offering OBCs, design of their OBCs, operations of their OBCs, and recycling of their machines involved in offering. We asked questions related to these decisions in two phases. During the first phase, we asked the representatives of companies to share and briefly comment on who takes ownership of assets and the responsibilities related to various design, operations, and recycling decisions when it comes to offering

OBC (Appendix I). Whereas, during the second phase, due to the time limitation, we discussed the three most important decisions while offering OBCs that were identified by the company representatives.

To develop the interview questions, we considered the typology proposed by previous studies (Lay et al., 2009; Hypko et al., 2010) regarding the decisions that manufacturing enterprises consider while offering servitization concepts like performance-based contracts. Since the previous studies (Lay et al., 2009; Hypko et al., 2010) were done more than a decade ago, we also considered a few more decisions based on our understanding. For example, when it comes to ownership, we asked who owned assets such as the machine during and after its phase of use (Lay et al., 2009; Hypko et al., 2010), software, data, and raw materials. Similarly, regarding the design phase, we asked about the importance of various decisions and their responsibilities, such as the type of OBCs offered (Lay et al., 2009; Hypko et al., 2010), machine utilization level, installation and logistics of the machine, duration of the contract, contract handling responsibility, and terms of penalty. Moreover, we asked questions about the importance of operational decisions and their responsibilities, such as location of operation for the machine (Lay et al., 2009; Hypko et al., 2010), skills and training of personnel, manufacturing of end products by using machine, and machine maintenance. Finally, we also asked who took responsibility for recycling and scrapping the machine.

At the beginning, the scope of the study was explained to representatives of the companies. The interviews were conducted virtually via the Microsoft Team platform. In addition, we also video and audio recorded our interviews. Moreover, we used Thinktank, an online platform, to conduct interviews. Thinktank allowed the interview participants to write their responses regarding the questions, and we were also able to see the responses of the participants. Furthermore, at the end of the first phase, the company representatives could see all the responses and were able to modify them. Similarly, the Thinktank facilitated the representatives in identifying the three most important decisions from their company's perspective (as all the decisions were displayed together on their screens).

Table 1. Company background.

Background dimensions	Company A	Company B	Company C	Company D
Type of Enterprise	Machinery and Equipment Manufacturing	Metal Product Manufacturing	Fabricated Metal Product Manufacturing	Electronics Inspection
Size of Enterprise	SME	SME	SME	SME
Company started	2010	1972	1985	2018
Turnover	≈ 2.5 m€	≈ 6.6 m€	≈ 18 m€	≈ 6 m€
Type of OBC	Hybrid output OBC & economic OBC	Output OBC	Availability OBC	Output OBC
Years since OBC is offered	5	2	2	2
Primary function of the machine	Producing industrial gases	Processing metals	Metal and sheet metal processing	Inspection of electronic hardware and software
Standard/ Customized machine	Standard	Standard/Customized	Standard/Customized	Standard
Degree of machine criticality for customer	Less critical	Highly critical	Highly critical	Highly critical
Location (headquarters)	Northern Europe	Central Europe	Central Europe	Southeast Asia
Interview Representative	Director (Partners)	Director	Director	Founder and CEO
Mode of interview	MS Teams and ThinkTank	MS Teams and ThinkTank	MS Teams and ThinkTank	MS Teams and ThinkTank
Fleets	Not offering	Not offering	Not offering	Not offering
Movable/ Installed equipment	Installed	Installed	Installed	Plug and Play

Data Analysis: The transcripts during the current study were in the form of audio-video files, interview notes, responses on Thinktank, and websites and reports of the companies. For the analysis of companies, the recorded interviews and Thinktank responses were manually coded (Appendix II). We also contacted the company representatives after the interviews to discuss the preliminary results of our study and obtain more details on the incomplete information.

Since data from different sources, like interviews, responses on Thinktank, websites, and reports of the companies, converged towards the same results, triangulation was observed (Yin, 2003). Our research also satisfied construct validity, internal validity, external validity, and reliability (Yin, 2003). As the company representatives reviewed the final version of the case analysis, construct validity was satisfied. As the study was not causal in nature, internal validity was not required (Yin, 2003). The external validity was checked with the help of literal and theoretical replications during the research design phase. Finally, different members of the research team independently interpreted and analyzed the data and obtained the same results; therefore, reliability was also satisfied.

4. Results

In this section, we discuss the results. Section 4.1 presents the results related to the challenges faced by SME MMs while offering OBCs and the ways to mitigate these challenges. In section 4.2, the benefits received by SME MMs while offering OBCs are discussed. The company names were mentioned for a challenge, mitigation, or benefit when they directly referred to them. As the challenges, risks, and mitigations were not asked (refer to section 3: Data collection and analysis), at times company representatives did not suggest something as a challenge but implemented ways to mitigate those challenges.

4.1 Challenges Faced by SME MMs While Offering OBCs and How They Mitigate These Challenges

The challenges, mitigation ways, and company representative quotes corresponding to both the challenges and the mitigation ways have been presented in Table 2.

Ownership of expensive machines

Challenge (Companies A, B, C, D): The SME MMs stated having several financial limitations. Therefore, offering OBCs was found by all companies to require huge capital to finance expensive machines (see Table 2). As a result, it was experienced as a unique SME MM challenge to acquire the huge amount of capital to offer OBCs.

Mitigation (Companies A, B, C): The SME MMs stated that they have been trying to identify a third party that can own the expensive machines offered during the OBCs. When a financial instrument, such as a third party is involved in the ownership of expensive machines, SMEs can mitigate the risks of owning such machines. In this regard, two out of four of our companies (A, B) were already getting third-party financing while offering OBCs (see Appendix I), whereas the representative of Company C suggested that they were trying to identify a partner for financing. Further, company D self-finances its OBCs and recognizes that this is a risk because they are an SME (see Table 2).

Long payback periods of OBCs

Challenge (Company A, B, C, D): In investment-based models, MMs are paid to sell their machine. However, the transition towards OBCs is complicated, as the payback time is longer than that of investment-

based models. As a result, OBCs need long-term financing before the payback time is reached and profit starts to accumulate (see Table 2). For SME MMs, sustaining this long payback time is not easy.

Mitigation (Companies A, B, C, D): The SME MMs look for separate contracts, to ensure minimum earnings to mitigate the challenge of long payback periods in OBCs. These separate contracts as shown by all four companies, are related to activities such as installation of the machine, skill enhancement training of the personnel involved in operating the machine, machine logistics, and machine maintenance (see Appendix I). In this regard, all four companies used installation and maintenance as separate contracts. Skill enhancement and training of personnel are used by companies A, B, and C, and logistics are used by companies A, C, and D as separate contracts for earnings (see Table 2).

Customers not utilizing the machines

Challenge (Company D): In OBCs, the earnings of SME MMs depend on the customer's machine utilization. However, the OBCs do not work in favor of SMEs, as their earnings are reduced if customers do not utilize the machine (see Table 2).

Mitigation (Companies A, B, C): The penalty and contract duration terms are designed to guarantee minimum earnings for SME MMs. Penalty terms ensure that there is a minimum fee for SMEs to earn even when the customer is not using the machine (see Appendix I). Similarly, SME MMs use variable pricing strategies. In variable pricing, the machine usage level by the customer is continuously monitored, and if it is sufficiently high, then a new pricing favoring the SMEs is negotiated with the customer (see Table 2).

Similarly, the duration of OBCs is very long (see Appendix I). Companies B and C have contracts for 1-5 years. However, company A has a continuous contract that is automatically renewed after the end of each year. If the customer of company A wants to end the contract, the customer needs to inform company A one year in advance. Thus, it provides company A with sufficient time to identify a new customer.

IP Protection

Challenge (Company D): IP provides a competitive edge for technology-oriented companies. The IP might be in the software, hardware, or both. Technology-oriented companies are very protective of their IP, and they avoid dealing with customers in countries where the legal system is not very strong. Overall, SME MMs are selective in choosing customers while offering OBCs (see Table 2).

Mitigation (Company D): SME MMs have a strong legal contract for offering OBCs. A strong legal contract ensures that their IP cannot leave their grasp. Moreover, even if someone has copied their IP, they are ready to defend their own case. Furthermore, SME MMs only offer OBCs to customers located in countries with strong legal systems (see Table 2).

Need for constant innovation

Challenge (Company B): SME MMs, while offering OBCs, also face enormous competition from other SMEs and large enterprises. In this regard, they need to constantly innovate. Moreover, SMEs need to be careful to survive and avoid mistakes while offering OBCs. Consequently, they also need access to the data generated by the machine when it is with the customers.

Mitigation (Companies C, D): When SME MMs offer OBCs, they can access the machine data. Analysis of this data reveals how the customer has been using the machine. Thus, improvements and innovations can be implemented in the machines. These innovations will lead to customer satisfaction. Our data showed that all four companies had access to the machine-related data from the customer (see Table 2).

Table 2. Quotes related to the challenges faced and mitigation ways by the interviewed small and medium-sized machine manufacturers when it comes to offering outcome-based contracts.

#	Challenge faced	Challenge Related Quote(s) by Company Representative(s)	Mitigation of Challenge	Mitigation Related Quote(s) by Company Representative(s)
1	Ownership of expensive machine	Company D: '…OBC growth is limited, because we are SME, we need capital to execute OBC…'	Involve third party to own the expensive machine	Company A: '…(machine) owned by financing partner for some part of the duration of use…' Company B: '…financial strength is different because we are SME, we cannot do OBC direct, our company and end customer needs the third part financing, at the moment we have worked through 3rd party financing, maybe in future other options…' Company C: '…. our company owns the machine…trying to find a partner (third party) who will own the machine…. when turning from investment-based model to OBC turnover is dropping dramatically….'
2	Long payback period of OBCs	Company C: '…when turning from investment-based model to OBC turnover is dropping dramatically…'	Offer separate contracts to ensure minimum earnings	Company B: '…. we sell our machines with training included…it is limited period usually during the machine installation…we also have remote training or training for new employees…this is important for us….'
3	Customers not utilizing the machines	Company D: '…. if the customer is not using machine, you are not earning anything, minimum is not enough….'	Defining penalty terms and contract duration to ensure minimum earnings	Company C: '…if customer is using machine a lot that will be divided for months…. if customer does not use machine a lot there will be a discussion about increased price…they do not have fixed minimum price for contract…'
4	IP Protection	Company D: '…machine consists of two parts…hardware part and software part (license model) …. problem some of these technologies can be copied…'	Designing strong legal contract	Company D: '…. make sure that legal paper is good, not easy for SME. (we offer OBC) in countries where legal system is strong…target is larger companies to minimize risks…'
5	Need for constant innovation	-	Get access to the machine-related data	Company D: '…. keeping the ownership of machine, we can do continuously improvements to machine and keep customer satisfaction at the highest level, no permissions needed (for data) etc. Customer loved when we do new improvements to the machine, and we don't charge it….' Company C: '…this is what we want to learn from each customers data to make our machine better…'
6	Offering required performance	Company D: '…if installation doesn't work, we cannot make money…'	Taking responsibility of activities like training, maintenance, and installation, and getting access to data	Company B: '…it (installation) is the heart of the business delivery…you can fulfill your contract…and after installation has done you are basically out of risk and responsibility…this is critical in terms of machinery business…' Company B: '…we sell our machines with training included…it is limited period of time usually during the machine installation…we also have remote training or training for new employees…this is important for us…' Company B: '…it is written in the manuals what kind of components (raw material) you can process with our machines…. customers have specific instructions for this…' Company B: '…(data) this is relevant for customers and our company in order to see the behavior of parts and life stand and stuff like that…but it can be shared by customer only, so it does not belong to us…the third party does not care about the shape of the product…they care about the performance of the machine…they care about use-based data…'

Delivering the required performance

Challenge (Company D): If the stipulated performance is not delivered in OBCs, then the SME MMs are penalized. At times, the use of incorrect raw materials, incorrect installation, improper maintenance, or

customers not taking proper care of the machine can lead to a failure to deliver the required performance (see Table 2).

Mitigation (Companies A, B, C, D): When SME MMs offer OBCs, they ensure delivery of performance by following various measures. First, they maintain the responsibility for activities such as installation, maintenance, and skill enhancement training for personnel. Our data showed that the responsibility for installation and maintenance belonged to all four companies. The responsibility for skill enhancement and training of employees using the machine was with companies A, B, and C. The machine in company D did not require any training as it only required switching on and off. Furthermore, detailed instructions regarding authorized raw materials that can be processed with the machine and how the process takes place are also mentioned by the SME MMs to avoid maintenance (see Table 2).

Moreover, SME MMs also have access to data. The data allows them to see how various parts of their machine behave and when they need to be repaired or replaced. These measures of predictive maintenance also ensure the delivery of the required performance. All four companies had access to the data generated by the machine at the customer's location (see Table 2).

4.2 SME MMs Benefits While Offering OBCs

The challenges, mitigation ways, and company representative quotes corresponding to both the challenges and the mitigation ways have been presented in Table 3.

Table 3. Quotes related to the benefits by the interviewed small and medium-sized machine manufacturers when it comes to offering outcome-based contracts.

#	Benefits	Benefit Related Quote(s) by Company Representative(s)
1	Entering competitive markets	Company A: '…machine is so much more expensive than competitor's machine that it is not possible to sell it as an investment product…customers didn't believe performance level enough in the beginning to pay such a high price for the machine…with OBC it is possible... third party financing is used to finance machines….'
2	Sales and marketing of OBCs	Company B: '…third party financing is one more sales tool to get more business…'
3	Optimizing the cost of operating the machine	Company B: '…(data) this is relevant for customers and our company in order to see the behavior of parts and life stand and stuff like that…but it can be shared by customer only, so it does not belong to us…the third party does not care about the shape of the product…they care about the performance of the machine…they care about use-based data…' Company B: '…it is written in the manuals what kind of components (raw material) you can process with our machines…. customers have specific instructions for this…' Company D: '…. training of personnel is very important to keep machine up and running….' Company D: '…. if installation doesn't work, we cannot make money….'Benefits related to avoiding money laundering and legal issues Company D: '…. make sure that legal paper is good, not easy for SME... Used in countries where legal system is strong…' Company D: '…. risk managing/funding asset…you have to select/check customer carefully… target is larger companies to minimize risks… down payment is used to minimize risks…'
4	Reducing the investment through recycling the machine and its components	Company D: '…. machine components (sophisticated electronic parts) are reused, mechanics (mechanical parts) not normally reused…' Company D: '…. machine comes back, refurbish, and sold again as OBCs…'

Benefits related to entering competitive markets

With the help of our data, we observed that one of the studied companies (Company A) considered OBCs a boon to bring its machine to market. Selling expensive machines through the investment-based model was a challenge for SME MMs. Moreover, the presence of competitors with lower prices further magnified

the challenge. However, with OBC, it was possible for customers to use third-party financing and prefer using a machine with higher output as compared to the competitor's machine.

Benefits related to sales and marketing of OBCs (Company B)
With the help of the data collected from the four companies, we also found that one of the studied companies (Company B) observed benefits related to the growth of their OBC. OBCs can open opportunities for niche markets and customer segments that are not available when SME MMs offer investment-based models. The OBCs provide an additional new sales channel when third-party financing is used. The financing company acts as an additional sales channel (see Table 3).

Benefits related to optimizing the cost of operating the machine (Companies A, B, C, D)
Offering OBC allows SME MMs to optimize the cost of operating the machines. The operating cost of the machine was optimized during OBCs for the following two reasons: First, while offering the OBC, the SME MMs had access to the data produced during the operations performed by the machine. Access to data allows the analysis of data and the study of the entire machine and its different parts. This ensures that the machine is utilized in the most efficient manner. The data collected from all four companies revealed that they had access to machine-related data generated at the customer's location (see Table 3).

Second, SME MMs that offer OBCs spend less on maintenance-related activities. While offering OBCs, the authorized materials that need to be used with the machine are stated in the manuals (see Table 3). Similarly, SME MMs train the employees of their customers who will be working with the machine. This training also reduces the chances of machine breakdown due to improper use by employees (see Table 3). Further, the correct installation of the machine is necessary for the proper functioning of the machine involved during OBCs. As a result, SME MMs also take responsibility for installing machines at the customer's location. Thus, maintenance-related issues are reduced because of the installation of the machine (see Table 3).

Offering OBCs does not involve any one-time payment for the machine by the customer. Rather, it involves continuous, periodic payments by the customers. As a result, there may be default customers who are unable to pay the required amount. Further, it is troublesome from a financial and resource perspective for SMEs to fight legal battles. Therefore, SME MMs offer their OBCs to large companies located in developed countries where the legal system is strong. Similarly, SME MMs also check customer profiles carefully and ask them for down payments (see Table 3).

Benefits related to reducing the investment through recycling the machine and its components
SME MMs use sophisticated machine components when offering OBCs. In investment-based models, these components must be sourced from suppliers. However, when offering OBCs, SME MMs can get the machine back once the contract is over. Based on the machine and its components, either they can offer the entire machine or some of its components in their existing OBCs, or they may repair the machine and offer it in their next OBCs. Thus, OBCs reduce the investment involved in offering a machine by recycling the machine and its components (see Table 3).

5. Discussion

Below, we present a discussion of our results in sections 5.1 and 5.2, respectively. We discuss the presence of several factors related to the challenges, mitigation, and benefits from the perspective of offering OBCs. Whereas the theoretical and managerial implications are presented in sections 5.3 and 5.4.

5.1 SME MMs Challenges and Mitigation of These Challenges While Offering OBCs

We found that there are major challenges and their mitigation ways that were considered critical by the studied SME MMs while offering OBCs (RQ1 and RQ2). These challenges are critical because all the diverse companies studied and those working with different business logics identified them. Therefore, these challenges might also be significant for other SME MMs and should be investigated further. Furthermore, through interviews, we found that SME MMs were able to mitigate these challenges by employing various strategies.

Ownership of the expensive machine

Due to the cost of the machine, owning the machine is a challenge for any company offering OBCs. However, with the help of our analysis in the current study, we identified that owning an expensive machine is a very critical challenge for the SME MMs offering OBCs. Moreover, we also observed that all four case companies have deployed various approaches to mitigate the challenge. For example, both company A and a third party partially own their machines. While, for company B, a third-party completely finances their machines. Company C owns the machine for now; however, they are actively looking for a third party to own the machine. Finally, company D owns the machine. However, due to being in a developing country, it is difficult for them to find third-party financiers who understand OBCs and are ready to own expensive machines. The main source of earnings for company D was through the licensing of their software; therefore, they were able to survive the challenge of owning the expensive machine. The challenge of owning an expensive machine may not be that critical for large enterprises, as the financial resources are available to them (Mittal et al., 2018). Likewise, due to available assets and negotiation powers, it is easier for large enterprises to get loans at a comparatively lower interest rate (Dietrich, 2012). In addition, the large enterprises may not involve third parties to avoid sharing the profits that OBCs will make. Furthermore, to get legal and tax advantages and for easier bookkeeping purposes, the large enterprises may even create a separate division or a subsidiary company for financing their OBCs (Lenka et al., 2018). Large enterprises might need the support of third parties when they are offering fleets of machines in their OBCs. On the other hand, SME MMs cannot even think of offering fleets of machines without getting support from third parties. Overall, owning an expensive machine while offering OBCs is a very critical challenge for SME MMs, and the four companies studied have suggested ways to mitigate this challenge.

Long payback period of OBCs

Longer payback periods become a major challenge while offering OBCs, as the cash flow during the transition phase is slower and reaching break-even takes longer. Moreover, for SME MMs, it becomes even more critical to generate earnings during the initial period of offering OBCs. However, SME MMs can also start by offering a hybrid of investment-based models and OBCs to ensure earnings. Once they start earning from OBCs, they can make a smoother transition towards offering pure OBCs. Further, when the machines have a longer lifetime and it takes a few years to achieve break-even point, the SME MMs need to make a tradeoff. This tradeoff is between minimizing risks by involving a third party to own the machine and sharing a major proportion of profits with them and maximizing risks by not involving a third party to own the machine and getting all the profits. Large enterprises have multiple businesses running (Muller et al., 2018), and therefore, they can wait for longer payback periods in OBCs. In this regard, all our interviewed SME MMs started to serve separate contracts for services like maintenance, installation, and training to ensure constant earnings. Overall, the long payback period is a very critical challenge for the SME MMs offering OBCs, and the four studied companies have suggested various ways to mitigate this challenge.

Customer Not Utilizing the Machine

The earnings in OBCs are based on the outcome delivered by the machine. If the machine is not being utilized, it will not produce any outcome and there will be no earnings. Thus, further building the limitations

of finances (Mittal et al., 2018) and limited sources of income (Muller et al., 2018) from the perspective of SME MMs offering OBCs. The studied SME MMs have started to use variable pricing strategies to overcome this challenge. In the variable price strategy, the customer pays a minimum fee even when they are not utilizing the machines, and if the customers use the machine, then they need to pay based on the output. Further, some SME MMs (e.g., companies' B and C) may offer customized machines, where the role of their machines would be very critical for customer operations, thus reducing the chances of machines not being utilized. Likewise, SME MMs can also focus on serving multiple customers at the same time to enhance the utilization of their machines. For example, their machine can be transported to different locations during the day to serve multiple customers. Therefore, this important problem of machines not being used by the customer will not be faced when machines are of a movable nature. However, the machine would not be able to serve multiple customers if it were installed at the customer's premises.

IP Protection

IP plays a critical role in offering OBCs, as it helps in monitoring the machine. IP can take many forms, such as hardware, software, data, and technology. SME MMs like Company D also want to protect their IP while offering OBCs by taking ownership of various forms of IP. If their IP is in conflict, then the SME MMs will face issues related to their limited financial resources (Mittal et al., 2018) and the specialized expertise (Mittal et al., 2018; Lenka et al., 2018) in their own field. This might not be a challenge for large enterprises, SME MMs who do not have their IP in machines, or SME MMs like company A that have patented their IPs and are located in places where there are strong regulations to protect IP. Therefore, company A did not consider IP a critical challenge, whereas company D, even after having patented their IPs because of their location, considered IP protection a major challenge. Further, ownership of IP can also protect SME MMs from third parties who are ready to finance and own the machine.

Need for Constant Innovation

Additionally, interviews with the representatives of the companies' C and D led to the identification that SME MMs also face tough competition from other SMEs and large enterprises, and they need to find novel ways to be more innovative and competitive. Further online connectivity of machines ensures data collection and analysis in real-time. Analyzing the data produced by their machines can lead to further improvements in the design of the machine and software features. The improvements and innovations in the machine will improve the machine's performance and reduce the cost of operations from both the customer's and SME MM's perspectives. Thus, the SME MMs offering OBCs would be able to differentiate themselves based on the costs. In investment-based models, SME MMs did not have access to data, but OBCs facilitate access to data and customer feedback. Thus, leading to innovations in machines. In investment-based models, the SMEs face the issue of accessing the data related to machines (Chan and Chung, 2002), and their research department is also not that active (Lenka et al., 2018). However, by offering OBCs, the SME MMs can overcome these limitations and become more competitive.

Delivering The Required Performance

Limited financial resources (Mittal et al., 2018) and limited information accessibility (Chan and Chung, 2002) make it challenging for SME MMs to deliver the required performance. If this performance is not delivered, then the SME MMs will be penalized. SME MMs take responsibility for installation (companies A, B, and C; company D's machine is plugged) and maintenance (all four companies), training the customer employees working with the machine (companies A, B, and C) to ensure that the machine is handled with care. In addition, SME MMs avoid maintenance by mentioning detailed instructions regarding the type of raw materials that can be processed by the machine and how the raw material needs to be processed. Further, the SME MMs, while offering OBCs, can, with the help of data analysis, perform preventive maintenance

and avoid machine downtime to deliver the required performance. As discussed earlier, all these responsibilities that SME MMs have also come with earnings.

5.2 SME MMs Benefits While Offering OBC

We also identified various benefits for SME MMs while offering OBCs (RQ3). These benefits were not observed by the studied SME MMs while they were offering machines in investment-based models.

Benefits related to entering competitive markets

In investment-based models, there are limited revenue sources. Similarly, external funding and innovation that can happen through the use of cutting-edge technology and data analysis in OBCs are comparatively slow. Thus, SMEs find it difficult to compete with large enterprises and enter competitive markets. However, while offering OBCs, SMEs can enter competitive markets (markets dominated by incumbents) with machines that are expensive and high-end in terms of technology through OBCs by overcoming finance (and other) key challenges through mitigation efforts mentioned in RQ1 and RQ2, respectively.

Benefits related to a novel way of sales and marketing of their OBCs

Traditionally, because of the limited availability of financial resources and personnel, SMEs find it difficult to find new customers by improving their sales and marketing strategies. However, with the help of the current research, we identified that even third parties can join hands with SME MMs (e.g., company B) towards the sales and marketing of their OBCs by spreading in niche markets. The customized machines produced for niche market customers reduce competition as there will not be other MMs producing such a customized machine. Moreover, the niche market will lead to long-term, loyal customers. Thus, guaranteeing the cash flows. As third parties have financed the equipment, they will also try their best to find new customers.

Benefits related to optimizing the cost of operating the machine

In investment-based models, where the customer owns the machine, the collaboration between the MM and the customer is minimal to the extent of making deals for purchasing, and thus, optimizing the cost of operating the machine is very complicated. However, in OBCs, the MMs are responsible for the additional activities required to deliver the outcome of the machine. With the help of our four SME MMs, we identified that SME MMs can optimize the operating cost of machines using the following approaches: analyzing their machine-related data, training employees and customers who will be working with the machine, and maintaining the responsibility of machine installation and machine maintenance. However, if a machine (e.g., company D) does not require installation, training of employees and software maintenance can be done remotely. Furthermore, if this machine is movable, then the manufacturer's trained employees can take care of all these responsibilities and transport it to the customer's site to deliver the required outcome. Overall, the cost of operations can be optimized while offering OBCs.

Benefits related to avoiding money laundering and legal issues

In addition, offering OBCs creates a comparatively long-term relationship between the customer and manufacturer as compared to investment-based models. Therefore, we also identified that SME MMs (e.g., company D) may reduce their risks of offering OBCs by not offering OBCs to other SMEs and large enterprises that are established in countries where the legal system is not strong and asking customers to make down payments. Large enterprises may not need to follow these ways of offering OBCs. As large enterprises have the funds and networks to sustain legal and money laundering issues. Thus, OBCs offer unique ways for SME MMs to avoid money laundering and legal issues.

Benefits related to reducing investment through recycling the machine and its components
As SME MMs can get their machine back once the contract is over (e.g., company D). If the machine cannot be offered in the next OBC, they may use sophisticated electronic components for another machine. Similarly, they can refurbish the mechanical parts of the machine and use it to offer OBC to the next customer. This recycling of machine and its components also leads towards IP protection and sustainability. SME MMs do not have this benefit when they offer investment-based models, as they may not be able to control the reverse supply chain of the machine and its components.

5.3 Theoretical Implications

Overall, with the help of the current research, we identified the challenges, ways of mitigating the identified challenges, and the unique benefits that SME MMs have when they offer OBCs. The existing scientific literature on OBCs mostly focuses on large enterprises (Barquet et al., 2013; Gebauer et al., 2017). We add to the previous study (Adrodegari et al., 2017) by focusing on OBCs offered by SME MMs.

The previous study suggested that SME MMs offering OBCs face challenges related to changes in customer conditions and service personnel, cost estimations, and customer interest, whereas we identified that SME MMs face various other challenges, such as ownership of expensive machines, long payback period of OBCs, protection of IP, the need for constant innovation, and delivering the required performance while offering OBC. Similarly, the previous study also suggested that their identified challenges can be mitigated by penalizing customers for changing the contract conditions initially present in the contract. However, our studied SME MMs mitigated their challenges by involving third parties to own the machine, offering separate contracts to ensure earnings, keeping ownership of IP, getting access to data for innovation, and taking responsibility for activities like maintenance, installation, and training to ensure the required performance. Finally, a previous study suggested that SME MMs, by offering OBCs, can predict failures. Whereas we identified that SME MMs can also have benefits such as entering competitive markets, optimizing the cost of operating the machine, finding novel and efficient ways of selling and marketing machines, avoiding money laundering and legal issues, and reducing investment through recycling the machine and its components while offering OBCs.

5.4 Managerial Implications

The current research can also help the managers of SME MMs that plan to offer OBCs. The identified challenges and their mitigation ways will inform the managers regarding how they can overcome those challenges. Furthermore, the managers can evaluate if the challenges and mitigation ways apply to their organization. For example, it might be difficult for an SME MM to find a third party to own their expensive machine; similarly, there might be a machine that does not need to be switched on and off, thus not requiring maintenance and installation. In such cases, the manager of an SME MM needs to identify alternate options for owning the machine and offer separate contracts. Furthermore, the identified benefits can also motivate the managers of SME MMs to offer OBCs to get unique competitive advantages and create new customers.

6. Conclusions

We identified that despite being diverse in many aspects, such as the nature of the company, type of OBC offered, and criticality of the machine, we found the presence of several factors, such as limited financial resources, limited negotiation powers, limited employee skills, limited sources of income, limited expertise, and limited information accessibility, that affect SME MMs when they offer OBCs. Thus, demonstrating that company size matters when SME MMs are offering OBCs. Despite all the limitations, we show four successful SME MMs that were able to successfully offer OBCs and mitigate the challenges faced while offering OBCs. Moreover, we also identified unique benefits that SME MMs gained while offering OBCs.

We conclude that there are critical challenges faced by SME MMs when offering OBCs. In more detail, we identified SME MMs specific challenges when offering OBCs (RQ1) that were related to the ownership of expensive machines, the longer payback period of OBCs, customers not utilizing the machine, protecting IP, the need for constant innovation, and delivering the required performance while offering OBCs. Based on our analysis, we also identified that some of these challenges, like ownership of the expensive machines and the long payback period while offering OBCs, were more critical for SME MMs. Owning the expensive machines becomes a challenge, as SMEs have limited financial resources (Mittal et al., 2018) and limited negotiation powers and assets (Dietrich, 2012), so owning such expensive machines and securing loans from financial institutes becomes difficult. Moreover, as SMEs have limited financial resources (Mittal et al., 2018) and limited sources of income (Muller et al., 2018), the long payback period while offering OBCs also becomes a challenge for SME MMs. Large enterprises may also face the identified challenges; however, due to the availability of financial resources, assets, high negotiation powers, and multiple businesses running in parallel, these challenges might not be that critical for them.

We further conclude that the mitigation ways identified (RQ2) in the current study provide a unique outlook towards solving the critical challenges identified in RQ1. These mitigation ways include involving third parties to own the expensive machines, ensuring earnings by including separate contracts for other activities such as installation, maintenance, training of employees working on machines, and logistics to overcome the challenge of a long payback period, designing favorable terms for penalties and contract duration to ensure utilization of machine, developing strong legal contracts to protect their IP, getting access to machine-related data for constant innovation, and taking responsibility for various activities such as installation and maintenance to ensure that the machine is able to offer the required performance. Based on our analysis, we also identified that some of these identified mitigation ways such as involving third parties to own the expensive machines and ensuring earnings by including separate contracts for various activities such as installation, maintenance, and training of employees, seemed to be more critical for SME MMs. When third parties or the financing partners are ready to own such expensive machines the SME MMs can overcome the limitations regarding financial resources, negotiation powers, and assets. Additionally, SME MMs, while serving separate contracts for additional activities and by offering hybrid investment-based models and OBCs, can ensure earnings and thus overcome their limitations related to financial resources and limited sources of income. However, since large enterprises do not have financial limitations, they have assets and negotiation powers, and they have multiple businesses running in parallel, the identified mitigations might not always be deployed by large enterprises.

Moreover, we also identified unique benefits that SME MMs can have while offering OBCs. These benefits are unique as they can only be observed when SME MMs offer OBCs. These benefits are related to entering competitive markets, optimizing the costs of machine operations, finding novel ways of sales and marketing of machine, avoiding money laundering and risk issues, and reducing investments through recycling machine and its components. Some of the benefits that are unique for SME MMs include entering competitive markets and novel ways of sales and marketing. SMEs can enter competitive markets dominated by incumbents with machines that are expensive and high-end in terms of technology through OBCs by overcoming finance and other key challenges identified in RQ1 and overcoming them through mitigation efforts mentioned in RQ 2. Similarly, in OBCs, third parties support sales and marketing and can help SME MMs enter niche markets. Entering niche markets will allow SME MMs to build brand loyalty and long-term customers (Galvão et al., 2018). Thus, ensuring constant cash flow for financially constrained SME MMs.

6.1 Limitations and Future Work

Although in our current research we studied four diverse SME MMs, there are many other SME MMs that exist, and the strategies for risk mitigation and overcoming challenges might be relevant for them to a different degree. As a result, future studies should identify the unique ways for risk mitigation and overcoming challenges that are followed by them while offering OBCs. Similarly, future research can focus on studying the unique benefits and advantages that other SMEs receive while offering OBCs. Additionally, a comparative study leading to similarities and differences between OBCs is offered by SME MMs, and large enterprises should also be studied. Finally, all four companies studied offered a machine that needed to be installed at the customer's site. In the future, SME MMs offering movable machines can also be studied for comparison.

The challenges and their mitigation strategies identified in the current research were critical because they were faced by different types of companies that worked with different business logic. Therefore, these challenges and their mitigation strategies achieved for SME MMs should be studied in future research. Similarly, identifying the unique benefits and advantages offered by OBC also leads to optimization of the cost of operations and sustainability. Such benefits can also motivate managers of SME MMs to offer OBCs.

Conflict of Interest
We do not have any competing interest.

Acknowledgements
This work was supported by Business Finland under Grant number 545/31/2020.

Appendix I: Category of Interview Questions and Answers of the Case Companies

Question categories	Specific questions under each category	Answers (Company)		
Who owns the following:	Machine (during phase of use)	SMMI (A, C, D)	Customer (B)	Third Party
	Machine (after phase of use)	SMMI (A, B, C, D)	Customer (A)	Third Party
	Software	SMMI (A, B, C, D)	Customer (A)	Third Party
	Production Data	SMMI (A)	Customer (B, C, D)	Third Party
	Maintenance Data	SMMI (A, D)	Customer (B, C)	Third Party
	Raw materials	SMMI (A, D)	Customer (B, C)	Third Party
Design of OBC	Machine utilization level	High (A)	Flexible (C)	
	Installation	SMMI (A, B, C, D)	Customer	Third Party (A)
	Logistics	SMMI (A, C, D)	Customer (B)	Third Party
	Duration of contract	1-5 years (B, C, D)	>5 years	Continuous (A)
	Contract handling responsibility	SMMI (A, C, D)	Customer	Third Party (B)
	Terms of penalty	Minimum Fee (A, B, D)	Variable Pricing ©	
Operational decisions	Skills and training of personnel	SMMI (A, B, C)	Customer (D)	
	Manufacturing of end-product	SMMI (C, D)	Customer (A, B)	
	Maintenance of machine	SMMI (A, B, C, D)	Customer	
Recycling	Scrapping, Upgrading	SMMI (A, B, C, D)	Customer (D)	

Appendix II: Coding of the Transcripts

We followed the steps (Smith et al., 2009) for manual coding of the transcripts.

Identifying broad themes: Three researchers started coding by identifying the broad themes by reviewing the transcripts and the research objectives; thus, three broad themes emerged. These themes were related to the challenges faced by the case companies, the methods followed by the case companies to mitigate the challenges, and the benefits that our case companies had while offering OBC. Initially, two researchers independently identified the data from transcripts of one case company for all three broad themes. Subsequently, the issues faced during coding and the meaning of each broad theme were clarified. Once the coding process was unanimously agreed upon, the two independent researchers coded the remaining three cases, and the third member reviewed the data present in the file of each case company for potential issues. At the end of this step, we had one file for each broad theme.

Decisions within each broad theme: Two researchers independently considered the first broad theme, that is, the challenges faced by case companies while offering OBC. After going through the file representing this broad theme, our research team decided to consider six themes: ownership of the machine, long payback periods, customers not utilizing the machine, protecting their IP, the need for constant innovation, and delivering the required performance. Since the broad theme of mitigating the challenges was related to the first broad theme, the first two broad themes were merged. Similarly, while considering the broad theme of benefits related to offering OBC or case companies, the following four themes were suggested: optimizing the cost of operating the machine, sales of OBC, identifying customers for offering OBC, and recycling the machine and its components.

Identifying similar traits: We observed that similar decisions influenced more than one broad theme. Therefore, two researchers discussed decisions that overlapped or were similar and were present in more than one broad theme. Finally, after being satisfied with the relevance of the decisions, they were either removed from one of the broad themes or kept in both broad themes. Finally, all the decisions and data for a broad theme were placed in a single Excel file.

Assessing content within a broad theme: We deployed both within-case and cross-case analyses to analyze our data (Yin, 2003; Anderson et al., 2010). We identified that some decisions pertaining to a broad theme were agreed upon by all four case companies, whereas decisions related to some broad themes were agreed upon by only three or two case companies. At times, decisions related to a broad theme were agreed upon only by a single company. This agreement depended on the nature of the industry and the business logic followed by the case company.

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