

**UNIVERSIDADE FEDERAL DO RIO GRANDE DO SUL
ESCOLA DE ENGENHARIA
PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA DE PRODUÇÃO**

TESE DE DOUTORADO

**ENVOLVIMENTO DE FORNECEDORES DE SERVIÇOS
EM EMPRESAS DE PRODUTO VISANDO O
DESENVOLVIMENTO DA SERVITIZAÇÃO**

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Porto Alegre, 2017

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A minha esposa, Juliana, e a meus pais, Rafael e Claudia

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RESUMO

As empresas de produto que adotam uma estratégia de servitização, geralmente apresentam falta de conhecimento sobre a oferta de serviços associada aos produtos manufaturados. A aquisição de conhecimento externo de fornecedores de serviços pode ser uma maneira de enfrentar esse problema. O objetivo desta tese, composta por três artigos científicos, é analisar a relação empresa de produto-fornecedor de serviço em uma tríade de serviços disposta com o objetivo de oferecer pacotes produto-serviço aos consumidores. Este trabalho se concentra em três tipos de colaboração empresa-fornecedor que podem ocorrer (denominados *White Box*, *Grey Box* e *Black Box*) e sobre a dinâmica de compartilhamento de conhecimento (KS) dessa colaboração. Além disso, propõe-se que existem três dimensões de negócios principais (denominadas *service offering*, *resource base* e *activities system*) que as empresas de produto devem gerenciar na sua servitização e que o envolvimento de prestadores de serviços pode moderar os efeitos dessas dimensões sobre os benefícios obtidos no Sistema de Produto-Serviço (PSS) entregue. Para entender esse fenômeno, primeiro é empregada uma abordagem de múltiplos estudos de caso para analisar nove processos de BMI de empresas que transformaram seu modelo de negócios tradicional (BM) em BM servitizados. Em seguida, foram propostas hipóteses sobre o impacto dos fornecedores de serviços nos benefícios da servitização obtidos pelas empresas de produto. Para testar essas hipóteses, realizamos um levantamento quantitativo transversal em 104 empresas de produto brasileiras e italianas, analisando os dados por métodos de regressão quadrada, ANOVA e MANOVA. Como resultado, a partir da análise qualitativa, obtemos um quadro teórico que apresenta seis dinâmicas de KS possíveis para o desenho da servitização, combinando originalmente duas abordagens principais de BMI para a servitização (uma orientada ao produto e outra orientada ao serviço) e as três configurações principais de relacionamentos com fornecedores de serviços. Os resultados da análise quantitativa mostram que as três dimensões empresariais propostas são importantes para a servitização, enquanto há uma decisão de trade-off sobre o envolvimento dos fornecedores de serviços, uma vez que os fornecedores atuam de maneira diferente, dependendo da orientação do BMI. Ainda, nossas descobertas mostram que a configuração *Grey Box* é a melhor estratégia de colaboração, enquanto as configurações *White* e *Black boxes* têm diferentes contribuições dependendo da dimensão do negócio considerada.

ABSTRACT

Product companies that adopt the servitization strategy usually show lack of knowledge regarding the service offering associated to their manufactured products. Acquiring external knowledge from service suppliers can be a way to tackle this problem. The objective of this thesis is to analyze the relationship between product company and service provider disposed in a service triad with the objective of offering product-service packages to consumers. We focus on different types of collaboration that can occur (i.e. white, grey and black box configurations) and on the knowledge sharing (KS) dynamics of this collaboration. Also, we propose that there are three main business dimensions (i.e. service offering, resource base and activities system) that product companies have to manage in servitization and that the involvement of service suppliers can moderate the effects of these dimensions on the benefits obtained from the Product-Service System (PSS) delivered. To understand this phenomenon, we first employed a multiple-case study approach to analyze nine BMI processes from companies that transformed their traditional business model (BM) to a servitized BM. Then, we proposed some hypotheses about the impact of service suppliers in the benefits obtained by product companies from servitization. To test these hypotheses, we performed a cross-sectional quantitative survey in 104 Brazilian and Italian product companies, analyzing the data by ordinary least square regression, ANOVA and MANOVA methods. As a result, from the qualitative analysis, we obtain a theoretical framework that presents six possible KS dynamics for the servitization design by originally combining two main approaches for servitization-driven BMI (i.e. product-oriented and service-oriented product-service systems) and the three main configurations of relationships with service suppliers based on traditional new product development classifications of buyer-supplier integration. The results of the quantitative analysis show that the three proposed business dimensions are important for servitization while there is a trade-off decision regarding service suppliers' involvement since suppliers act differently depending on the BMI orientation (product or service-oriented). Also, our findings show that grey box is the best collaboration strategy, while white and black boxes have different contributions depending on the business dimension considered.

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1 INTRODUÇÃO

Nas economias mais desenvolvidas existe uma importante orientação dos negócios para o oferecimento de serviços, tendo estes uma maior participação no produto interno bruto (PIB) e no mercado de trabalho quando comparado com a fabricação de produtos (CHESBROUGH, 2011; NEELY, 2009). Além disso, pelo menos 60% das maiores empresas manufatureiras das economias ocidentais inseriram serviços em seus portfólios, sendo que aproximadamente um terço do seu faturamento provém destes (VISNJIC; VAN LOOY, 2013). O serviço, que antes era considerado pelas indústrias como um mal necessário para reter os clientes e como um custo indesejável, tem ganhado cada vez mais importância e, atualmente, tornou-se um fator fundamental na procura de satisfazer de forma mais completa as necessidades dos clientes. Assim sendo, as empresas manufatureiras vem oferecendo cada vez mais conjuntos de soluções ao invés de somente produtos, relações duradouras ao invés de simples transações momentâneas e a transformação de fornecedores em parceiros, tudo isso através da inclusão de novos serviços aos seus produtos (BAINES; LIGHTFOOT; SMART, 2011; FANG; PALMATIER; STEENKAMP, 2008; MARTINEZ et al., 2010; MATHIEU, 2001a; PAWAR; BELTAGUI; RIEDEL, 2009; VISNJIC; NEELY, 2013).

A tendência acima descrita foi denominada por Vandermerwe e Rada (1988) como Servitização (*Servitization*). Conforme estes autores, a Servitização consiste em inovar os modelos de negócios (BM – *Business Models*) tradicionais, baseados na simples oferta de produtos, em modelos onde são oferecidos pacotes combinados de produtos e serviços integrados, com vistas a aumentar o valor agregado oferecido ao cliente e melhorar os benefícios para a empresa (BAINES et al., 2009a; MARTINEZ et al., 2010; PAWAR; BELTAGUI; RIEDEL, 2009). A grande vantagem competitiva obtida pelas empresas que deixam a manufatura pura para oferecer também serviços representa uma ameaça àquelas empresas que não seguem esta tendência mundial (ELCHE; GONZÁLEZ, 2008).

Esta transformação do modelo de negócio representa um grande desafio para as empresas dedicadas a produtos (KINDSTRÖM et al., 2015). Diversos autores destacam como uma das principais dificuldades para a servitização o *gap* entre o conhecimento existente na empresa de produto – naturalmente focada no desenvolvimento e fabricação de produtos – e o conhecimento necessário para transformar seu modelo de negócio em um modelo servitizado que ofereça soluções integradas de produtos e serviços (CHIRUMALLA, 2013; LERTSAKTHANAKUN; THAWESAENGSKULTHAI; PONGPANICH, 2012; MEIER;

ROY; SELIGER, 2010). Como alternativa para preencher este *gap*, a literatura sugere que essas empresas se apoiem em fornecedores de serviços que já possuem o conhecimento e as capacidades necessárias, podendo complementar a oferta do produto com desenvolvimento de softwares, logística, manutenção, entre outros (BASTL et al., 2012; DAVIES, 2004; LOCKETT et al., 2011).

Quando as empresas de produto trabalham em parceria com um fornecedor de serviços de forma de conseguir oferecer uma solução produto-serviço para seus clientes, elas constituem uma tríade de serviço (*service triad*), como representado na Figura 1 (LI; CHOI, 2009; SILTALOPPI; VARGO, 2017). A relação entre empresa de manufatura e fornecedor de serviços em uma tríade é mais complexa do que a tradicional relação diádica normalmente observada em uma tradicional cadeia de suprimentos de produtos (KOWALKOWSKI; KINDSTRÖM; CARLBORG, 2016; WYNSTRA; SPRING; SCHOENHERR, 2015). Karatzas et al. (2017) apresenta um exemplo desta relação em que uma empresa montadora de caminhões do Reino Unido oferece a seus clientes contratos onde eles pagam uma quantia semanal para ter acesso a um grupo de serviços para a melhora do desempenho dos caminhões, como manutenção preventiva, peças de reposição, atendimento em caso de pane e tecnologia de telemetria para monitoramento do desempenho dos motoristas. Para a entrega destes serviços, a montadora conta com fornecedores de serviços independentes. Porém, a montadora mantém a exclusividade da venda dos veículos e, ainda, mantém o contato direto com seus clientes pessoa jurídica através de seus próprios gerentes de conta. Assim, pode-se observar que, diferentemente de uma cadeia de suprimentos de manufatura, neste contexto de Sistema Produto-Serviço (Product-Service System = PSS) a empresa de produto deve permitir aos seus fornecedores o acesso direto a seus clientes (LI; CHOI, 2009).

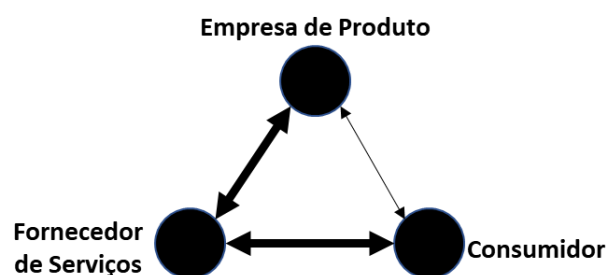


Figure 1: Tríade de Serviço. Adapted from Wynstra et al. (2015)

Neste cenário de colaboração para possibilitar a entrega do pacote produto-serviço, a gestão do conhecimento se apresenta como uma ferramenta essencial para que o conhecimento dos atores envolvidos, neste caso a empresa de manufatura e o fornecedor de serviços, possa permear e ser traduzido no projeto de uma solução produto-serviço bem-sucedida, assim como na reestruturação necessária da organização para suportar o novo modelo de negócio servitizado (DAHMANI et al., 2014). Neste sentido, a movimentação planejada do conhecimento desde as fontes geradoras do mesmo para os diferentes receptores torna-se essencial. Esse processo de movimentação do conhecimento entre unidades de negócios, entre subsidiárias, entre cliente-fornecedor, ou entre diferentes agentes da cadeia produtiva é denominado na literatura acadêmica como compartilhamento de conhecimento (KS) interorganizacional (CARLILE, 2004; DAVENPORT; PRUSAK, 1998; SZULANSKI, 2002).

Mesmo quando a relação entre empresa e fornecedor em uma tríade de serviços, e seu consequente KS, são apontados como fatores críticos para a servitização por diversos autores (por ex. (KARATZAS; JOHNSON; BASTL, 2017; KOWALKOWSKI; KINDSTRÖM; CARLBORG, 2016; LINDAHL et al., 2006; MARTINEZ et al., 2010), estes são assuntos pouco explorados na literatura da área. Ainda, os poucos autores que analisam estes assuntos, o fazem apenas de forma superficial. Por um lado, o KS é tratado de maneira simplista, como uma ‘caixa preta’ que pode ser entregue de um ponto a outro (MEIER; ROY; SELIGER, 2010; STORBACKA et al., 2013). Porém, autores advertem que existem tipos de conhecimento e diferentes graus de complexidade no compartilhamento de conhecimento entre atores (CARLILE, 2004; NONAKA; TAKEUCHI, 1995). Por exemplo, Carlile (2004) distingue entre três níveis de complexidade: (i) *transferência*, onde o conhecimento é considerado externo, explícito e armazenável; (ii) *tradução*, onde a complexidade do conhecimento demanda que este seja explicado ou traduzido de um ator para outro; e (iii) *transformação*, onde os atores precisam criar novos conhecimentos devido à complexidade do problema em questão.

Por outro lado, a gestão de fornecedores em uma tríade de serviços também é abordada de maneira simplista na literatura de servitização, como se existisse uma única forma de relacionamento entre a empresa e o fornecedor de serviços (BASTL et al., 2012; KARATZAS; JOHNSON; BASTL, 2016; SACCANI; VISINTIN; RAPACCINI, 2014). Porém, comparando os trabalhos de diferentes autores é possível identificar um comportamento diferente nestes relacionamentos. Por exemplo, fica claro que a relação

empresa-fornecedor apresentada por Wuyts et al. (2015), onde a empresa de manufatura terceiriza quase completamente os serviços, é diferente da relação apresentada por Karatzas et al. (2017), onde a empresa de manufatura desenvolve os serviços junto aos fornecedores de serviços. Assim, é possível realizar uma analogia com os três tipos de configuração empresa-fornecedor propostos por Petersen et al. (2005) para o contexto de desenvolvimento produtos: (i) White Box (o desenho é conduzido pela empresa), (ii) Grey Box (desenho compartilhado) e (iii) Black Box (o desenho é conduzido pelo fornecedor).

Esta tese propõe que na configuração White Box a empresa de manufatura é responsável pelo desenho completo e especificação da solução produto-serviço, enquanto que o fornecedor de serviços é envolvido principalmente nas últimas etapas do projeto, comumente na etapa de execução. Na configuração Grey Box, o desenho da solução é fortemente integrado e ambos os atores possuem o mesmo nível de responsabilidade e relevância no projeto. Conseqüentemente, a empresa de manufatura e o fornecedor de serviços trabalham em intensa colaboração desde a fase inicial até a execução. Finalmente, na configuração Black Box, a maior responsabilidade recai no fornecedor de serviços, quem fica responsável tanto pelo desenho quanto pela execução da solução produto-serviço, baseado nos requerimentos e especificações gerais da empresa de manufatura.

Dado este contexto, surgem as questões de pesquisa que norteiam a presente tese. Em primeiro lugar: (i) *como acontece o compartilhamento de conhecimento entre empresa e fornecedor de serviços para a transformação do modelo de negócio tradicional em um modelo servitizado?* Em segundo lugar: (ii) *como o envolvimento de fornecedores de serviços impacta nos benefícios obtidos da servitização pelas empresas de manufatura?* Finalmente, dado que a relação empresa-fornecedor pode ter diferentes formatos: (iii) *qual tipo de relação é o mais indicado de forma a obter maiores benefícios da servitização e como isto afeta as dimensões do negócio da empresa?* A presente tese propõe aprofundar essas questões, ampliando assim o estado atual do conhecimento sobre o assunto e propondo alternativas práticas para a tomada de decisão nas empresas.

1.1 Tema da tese

Diante das necessidades acima expostas, a proposta desta tese preocupa-se com o compartilhamento de conhecimentos (KS) interorganizacional para incentivar a inovação dos modelos de negócios (BM) visando a servitização. Neste sentido, esta pesquisa entende por KS ao processo que envolve a movimentação do conhecimento desde uma fonte para um

receptor e a subsequente absorção e utilização desse conhecimento, tendo como finalidade melhorar a capacidade para capitalizar experiências passadas e executar atividades (CARLILE, 2004; FRANK; RIBEIRO; ECHEVESTE, 2015). Segundo, por BM entende-se à forma em que uma empresa operacionaliza sua estratégia de negócio, definindo como a organização cria, entrega e captura valor (CORTIMIGLIA; GHEZZI; FRANK, 2016; DEMIL; LECOCQ, 2010; GHEZZI; CORTIMIGLIA; FRANK, 2015; MAGRETTA, 2002; OSTERWALDER; PIGNEUR, 2010). Por fim, por Servitização (Servitization) entende-se a uma forma específica de modelo de negócio que visa a inclusão de diferentes graus de serviços aos produtos, desde graus mais baixos onde se oferece um produto com alguns serviços de suporte, até os níveis mais avançados, onde se oferece um produto como serviço (product-as-a-service) (BAINES et al., 2009a; MANZINI; VEZZOLI, 2003; MONT, 2002; VANDERMERWE; RADA, 1988; VISNJIC; VAN LOOY, 2013; WISE; BAUMGARTNER, 1999).

1.2 Objetivo da tese

O objetivo geral desta tese é analisar a relação empresa de produto-fornecedor de serviço em uma tríade de serviços disposta com o objetivo de oferecer pacotes produto-serviço aos consumidores. Para que seja possível alcançar este objetivo geral, é necessário atingir os seguintes objetivos específicos:

- a) Identificar as principais formas de colaboração entre a empresa de produtos e os fornecedores de serviços para o desenvolvimento e entrega do pacote produto-serviço;
- b) Entender como acontece a dinâmica de compartilhamento de conhecimentos entre empresa e fornecedor de serviço no contexto da servitização;
- c) Identificar as principais dimensões do negócio que são afetadas pela servitização e a contribuição de cada uma destas para a obtenção dos benefícios esperados pela oferta de pacotes produto-serviço;
- d) Identificar qual o tipo de colaboração empresa-fornecedor mais adequado com base no impacto nas dimensões do modelo de negócio relacionadas à servitização e nos benefícios obtidos.

1.3 Justificativa do tema e dos objetivos

O tema desta tese envolve quatro áreas principais: (i) compartilhamento de conhecimento, (ii) inovação em modelos de negócio, (iii) servitização e (iv) gestão de fornecedores na servitização. Em primeiro lugar, a gestão do conhecimento é um tema que cresceu muito nas últimas décadas, tanto na esfera internacional como nacional (BARRADAS; FILHO, 2008; FRANK; RIBEIRO; ECHEVESTE, 2015). Atualmente, este assunto já alcançou um grau de maturidade como disciplina. Contudo, por não se tratar de um tema finalístico, mas um assunto de suporte, que permeia todas as disciplinas e linhas de pesquisa, o KS tem continuado a servir como uma abordagem teórica para tratar diferentes problemas da gestão organizacional. Em segundo lugar, recentemente tem ganhado força a utilização do BM como um meio para a introdução de mudanças incrementais ou radicais nas empresas, com foco na inovação (LINDGARDT et al., 2009; SCHNEIDER; SPIETH, 2013). A utilização do BM como agente de inovação permite que os tomadores de decisões estratégicas possam revelar fontes de valor novas ou antes ocultas (GHEZZI; CORTIMIGLIA; FRANK, 2015; ZOTT; AMIT, 2010). Em terceiro lugar, a servitização se apresenta como uma forte tendência global na indústria da manufatura que está obrigando às empresas a adaptarem seu modelo de negócios para satisfazer as demandas mais complexas dos usuários e clientes (BELAL; SHIRAHADA; KOSAKA, 2012a; BRAX; VISINTIN, 2016; KOHTAMAKI et al., 2013).

Finalmente, a gestão de fornecedores é um assunto muito desenvolvido na área de desenvolvimento de novos produtos e cadeias de suprimentos tradicionais, porém ainda muito pouco explorado no ambiente da servitização (BASTL et al., 2012; SACCANI; VISINTIN; RAPACCINI, 2014). Autores da área da servitização destacam a diferença existente entre uma cadeia de suprimentos baseada em produtos e uma que procura entregar pacotes produto-serviço (JOHNSON; MENA, 2008). Assim, é aclamada na literatura a necessidade de maiores estudos que analisem as particularidades da relação empresa-fornecedor no contexto da servitização, principalmente através de pesquisas quantitativas (BUSTINZA; PARRY; VENDRELL-HERRERO, 2013; PAIOLA et al., 2013; SACCANI; VISINTIN; RAPACCINI, 2014). Ainda, como comentado anteriormente, os poucos trabalhos existentes neste contexto (e.g. KARATZAS; JOHNSON; BASTL, 2016, 2017) tratam a relação empresa-fornecedor sem entrar no detalhe do tipo de relação possível entre estes dos atores, podendo perder assim importantes aspectos que podem influenciar os resultados obtidos desta parceria e seu impacto na estrutura da empresa de manufatura.

Assim, após as lacunas identificadas na literatura, observa-se a necessidade de uma pesquisa mais aprofundada que destaque as diferentes formas de relação empresa de manufatura-fornecedor de serviços dispostos em uma tríade de serviços, de forma a contribuir ampliando o conhecimento acadêmico nesta área e, ao mesmo tempo, apresentando claramente aos gestores de empresas de manufatura as possíveis alternativas de colaboração e seus impactos nos benefícios obtidos da Servitização.

1.4 Método de Pesquisa

Segundo a natureza da pesquisa, este trabalho enquadra-se como pesquisa aplicada. Isto se deve ao fato de que está orientada à geração de conhecimentos dirigidos à solução de problemas específicos (GIL, 2008). Em relação ao tipo de abordagem, esta pesquisa combina as abordagens qualitativa e quantitativa, que são utilizadas alternadamente, dependendo da etapa de trabalho em análise. Em relação aos objetivos, a primeira parte da tese trata de uma pesquisa exploratória (Artigo 1), uma vez que visa proporcionar maior familiaridade com o problema com vistas a torná-lo explícito, através do levantamento dos fatores principais de influência na relação empresa-fornecedor no contexto da servitização e a análise do impacto nas dimensões do negócio (GIL, 2008). Por outro lado, a segunda parte da tese (Artigos 2 e 3) tratam de uma pesquisa explicativa, uma vez que se propõem hipóteses que explicam uma realidade a serem validadas mediante a coleta de dados empíricos (GIL, 2008).

Para alcançar os objetivos, a condução deste trabalho ocorre através de três etapas apresentadas em três artigos científicos. A Figura 2 ilustra a evolução dos modelos conceituais através das etapas da pesquisa. A Etapa 1 busca, através da utilização de múltiplos estudos de caso, explorar e compreender como empresas de produto que almejam a servitização trabalham em parceria com fornecedores de serviço utilizando diferentes configurações. Para tanto, analisa-se em um framework (Figura 2) diferentes configurações de colaboração com o fornecedor e as formas de compartilhamento de conhecimento que ocorrem com este. A partir desse entendimento, a Etapa 2 busca entender, através de uma pesquisa quantitativa survey, como o grau de envolvimento das empresas de produto com seus fornecedores de serviço afeta as dimensões de negócio da empresa e os benefícios obtidos a partir da servitização (Figura 2). Finalmente, a terceira etapa busca identificar qual dos três tipos de configuração empresa-fornecedor identificados na Etapa 1 (*black, grey e white box*) apresentam um melhor desempenho referente às dimensões do negócio e aos benefícios previamente testados na Etapa 2. Isto também é realizado através dos dados da

pesquisa survey levantados na Etapa 2. Desta forma é possível criar um entendimento completo do fenómeno estudado.

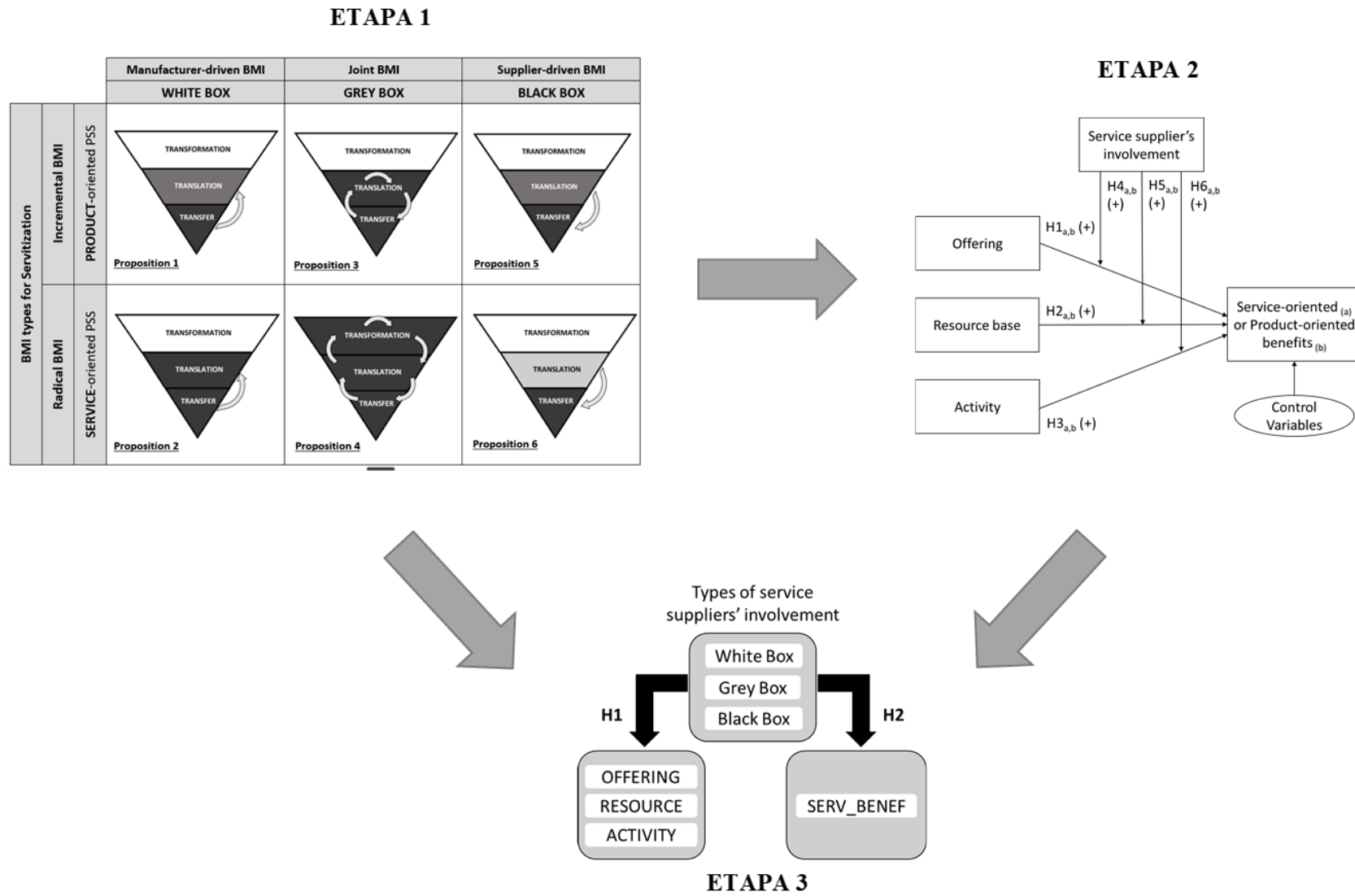


Figure 2: Modelo estrutural da tese (Fonte: elaborado pelo autor)

1.5 Delimitações do Estudo

O presente estudo se concentra na análise de três dimensões do negócio que foram identificadas como relevantes para uma implementação bem-sucedida da servitização. Contudo, existem outras propostas de dimensões clássicas dos modelos de negócios, como a de Osterwalder e Pigneur (2005) que propõe nove dimensões do modelo CANVAS. Essas propostas diferentes contemplam outras dimensões do negócio que não são contempladas diretamente nesta tese. Isto se deve ao fato que a consideração de muitas dimensões levaria a uma análise necessariamente muito detalhada. Portanto, delimitou-se o trabalho a dimensões mais genéricas para a compreensão da estrutura do negócio da servitização.

Os tipos de configuração da relação entre empresa de produto e fornecedor de serviço é restrito à adaptação de um modelo amplamente difundido na área do desenvolvimento de novos produtos (modelo *White/Grey/Black box*). Contudo, existem outras estruturas de tipos de colaboração que poderiam ser avaliadas, sendo esta uma opção de delimitação da estrutura analítica do trabalho.

Por fim, destaca-se uma limitação muito importante desta tese. O trabalho parte do pressuposto de que as empresas possuem um conhecimento prévio dos potenciais fornecedores de serviços que poderiam contribuir para o desenvolvimento da servitização. Em outras palavras, não se discute nesta tese como identificar fornecedores de serviços. A discussão está centrada no fato de entender como colaborar com fornecedores de serviços previamente identificados pela empresa. Assim sendo, o trabalho delimita-se na compreensão das formas de colaboração e da contribuição disto para as diferentes dimensões do negócio. Um escopo mais amplo deveria também incluir o processo de identificação dos parceiros, algo que não é o alvo da presente pesquisa.

1.6 Estrutura da tese

Conforme apresentado na Figura 1, esta tese está estruturada em quatro capítulos. O capítulo 1 apresentou o contexto teórico do problema abordado, apresentando os conceitos básicos que norteiam esta pesquisa e as lacunas de conhecimento existentes. Assim, são apresentados os objetivos da pesquisa e a justificativa de sua relevância tanto acadêmica quanto profissional. Os próximos capítulos, dois a quatro, apresentam os três artigos que compõem esta tese, conforme estrutura apresentada na Tabela 1. O quinto capítulo apresenta

as conclusões globais desta pesquisa, explicitando as contribuições teóricas e práticas junto com as limitações e proposta para futuras pesquisas.

Table 1: Estrutura da Tese em Artigos

Estudos	Objetivos	Questões de Pesquisa	Revisão Teórica	Método de Pesquisa
Capítulo 2: Artigo 1 ^(a)	Identificar as principais formas de colaboração entre a empresa de produtos e os fornecedores de serviços para o desenvolvimento e entrega do pacote produto-serviço. Entender como acontece a dinâmica de compartilhamento de conhecimentos entre estes atores.	Como empresas em busca da inovação do seu modelo de negócio para servitização integram conhecimentos dos seus fornecedores de serviços?	1. Inovação em modelos de negócio (BMI); 2. Envolvimento de fornecedores durante a BMI. 3. Compartilhamento de conhecimentos na BMI para servitização. 4. Tipos de relacionamento com fornecedores.	Pesquisa qualitativa: estudo de caso em empresas (entrevistas individuais).
Capítulo 3: Artigo 2 ^(b)	Identificar as principais dimensões do negócio que são afetadas pela servitização e a contribuição de cada uma destas para a obtenção dos benefícios esperados pela oferta de pacotes produto-serviço;	É o envolvimento de fornecedores de serviço uma boa escolha estratégica para empresas de produto que buscam a servitização?	1. Benefícios da Servitização; 2. Envolvimento de fornecedores na Servitização; 3. Dimensões do modelo de negócio para servitização.	Pesquisa quantitativa: survey com empresas aplicando CFA e regressão linear.
Capítulo 4: Artigo 3 ^(c)	Identificar qual o tipo de colaboração empresa-fornecedor mais adequado com base no impacto nas dimensões do modelo de negócio relacionadas à servitização e nos benefícios obtidos.	Qual o tipo de configuração de colaboração com fornecedores de serviços mais efetivo para empresas de produto que buscam a servitização?	1. Benefícios da Servitização; 2. Dimensões do BM para servitização. 3. Envolvimento de fornecedores na Servitização;	Pesquisa quantitativa: survey com empresas aplicando CFA e MANOVA.

^(a) Artigo aprovado para publicação no International Journal of Production Economics (Qualis Capes A1);

^(b) Artigo submetido ao Supply Chain Management: International Journal (Qualis Capes A1);

^(c) Artigo a ser submetido ao Supply Chain Management: International Journal (Qualis Capes A1)

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ARTIGO 1 – Knowledge sharing dynamics in service suppliers’ involvement for servitization of manufacturing companies*

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Abstract

Manufacturing companies that adopt the servitization strategy usually show lack of knowledge regarding the service offering associated to their manufactured products. Acquiring external knowledge from service suppliers can be a way to tackle this problem. The objective of this study is to understand how manufacturing companies aiming at a servitization-driven business model innovation (BMI) integrate such knowledge from service suppliers. We focus on different types of collaboration that can occur and on the knowledge sharing (KS) dynamics of this collaboration. We employ a multiple-case study approach to analyze nine BMI processes from companies that transformed their traditional business model (BM) to a servitized BM. As a result, we obtain a theoretical framework that presents six possible KS dynamics for the servitization design by originally combining two main approaches for servitization-driven BMI (i.e. product-oriented and service-oriented product-service systems) and three main configurations of relationships with service suppliers based on traditional new product development classifications of buyer-supplier integration (i.e. white, grey and black box configurations). Implications of combining a BMI and a buyer-supplier KS perspectives to investigate the process of servitization for manufacturing companies are then discussed.

Keywords: Business model innovation; servitization; product-service systems; knowledge sharing; buyer-supplier integration

1 Introduction

Several manufacturing companies are innovating their existing Business Models (BMs), traditionally centered in product offering, by adding services to their products or by delivering these products as services (BRAX; VISINTIN, 2016; KOHTAMAKI et al., 2013). This change is considered a form of Business Model Innovation (BMI) (KINDSTRÖM et al., 2015) and was originally termed ‘servitization’ by Vandermerwe and Rada (1988). Servitization aims to create additional value to customers by offering a whole solution in the form of a Product-Service System (PSS), which is more difficult to be imitated, thus helping to reduce the threat of product commoditization (BAINES et al., 2007; CHESBROUGH, 2011; LINDAHL; SUNDIN; SAKAO, 2014). Servitization can also determine higher and more stable profits, especially during economic downturns (BABU; SACHI, 2014).

The extant literature highlights some challenges that manufacturing companies are facing when dealing with servitization. Firstly, the adoption of a servitization strategy involves risks and uncertainties for the company, since it implies an important change in the BM that can impact directly on performance (BENEDETTINI; NEELY; SWINK, 2015; SUAREZ; CUSUMANO; KAHL, 2013). Secondly, changes may be needed in the manufacturing supply chain configuration and coordination, as new partners become relevant both for setting up the PSS offered and for sharing and reducing the associated business uncertainties and risks (PAIOLA et al., 2013; SACCANI; VISINTIN; RAPACCINI, 2014). These challenges are related to a deeper necessity: manufacturers need service knowledge in order to face such a BMI. Service-related knowledge is significantly different from that necessary for pure products design, and it may be hard for manufacturers to generate such kind of new knowledge by themselves (ALGHISI; SACCANI, 2015). Consequently, authors suggest that in order to support a servitization-driven BMI, manufacturers should acquire service knowledge from external service suppliers, these suppliers being an external organization or another business unit of the same company (BASTL et al., 2012; DAVIES, 2004; LOCKETT et al., 2011; MARTINEZ et al., 2010; WINDAHL; LAKEMON, 2006). Some examples on well-established manufacturing companies illustrate what the literature reports. Focusing on the automotive industry to allow comparability, one example is the collaboration between Fiat-Chrysler and Google, where the two companies are merging their engineering teams to develop self-driving cars (REUTERS, 2016b). Both companies want to keep their focus on their own core capabilities during the development of PSS solutions. Their

servitization strategy faces the challenge of coordinating joint product development activities from two different teams, since differences in culture, knowledge, and development methods, can be barriers among them. Another automotive company, General Motors (GM), invested in Lyft, its car-sharing service partner; as part of the agreement, GM participates in Lyft's board (REUTERS, 2016b). This allows GM to access to the partner's future plans and decisions. The servitization challenge in such case is how to gather access to strategic knowledge from the partner in order to keep the control of the business. Challenges are different in both cases regarding the buyer-supplier integration, the coordination mechanisms and the knowledge sharing dynamics between the partners.

Therefore, prior works highlighted that such manufacturer-service provider partnerships are only successful if they are carefully managed, which implies creating strong links of information and knowledge exchange (BASTL et al., 2012; JOHNSON; MENA, 2008; LOCKETT et al., 2011; WINDAHL; LAKEMON, 2006). As Lockett et al. (2011) affirm, the adoption of a servitization strategy can have a negative effect on manufacturing companies if the relationship with suppliers is not correctly defined. In this line, studies suggested that different forms of collaboration and level of interaction with suppliers can be established in servitization, as also shown in the two examples above (DAVIES; BRADY; HOBDA, 2007; FINNE; HOLMSTRÖM, 2013; HAKANEN; JAAKKOLA, 2012; KOWALKOWSKI; KINDSTRÖM; WITELL, 2011; NORDIN, 2008). The proper level of suppliers' involvement may depend on aspects such as: the financial objectives of servitization and the desired level of contact with customers (SACCANI, 2012); the service component's characteristics (PAIOLA et al., 2013; SACCANI; VISINTIN; RAPACCINI, 2014); the complexity of the solution (FINNE; HOLMSTRÖM, 2013); and the level of servitization targeted (BIKFALVI et al., 2013), among others. However, there is a gap in the literature which is the lack of understanding on how manufacturing companies can involve potential service suppliers in a servitization strategy and how knowledge can be acquired from these suppliers to better face a servitization-driven BMI (CHIRUMALLA, 2013; HAKANEN, 2014; LEONI, 2015; MARTINEZ et al., 2010; REIM; PARIDA; ÖRTQVIST, 2015; WINDAHL; LAKEMON, 2006).

The integration of external knowledge sources by means of Knowledge Sharing (KS) activities has been a typical concern in other research fields (e.g. ATHAIDE; KLINK, 2009; LE DAIN; MERMINOD, 2014; PETERSEN; HANDFIELD; RAGATZ, 2005) and it can constitute an insightful theoretical lens for a better understanding of the problems identified.

In this sense, KS can present different dynamics depending on the type of the buyer-supplier integration (LE DAIN; MERMINOD, 2014) and on the type of servitization-driven BMI adopted (BASTL et al., 2012; JOHNSON; MENA, 2008). The analysis of such dynamics can shed light on the existing gap regarding the way in which manufacturers acquire knowledge from service suppliers in different servitization contexts. Therefore, the following research question emerges and is addressed in this study: *How do manufacturing companies aiming at servitization-driven BMI integrate knowledge from service suppliers?*

This research question considers companies that are evolving from a traditional manufacturing BM to a new servitized BM focused on different levels of PSS. Moreover, our research question contributes to the existing state-of-the-art by addressing the servitization transformation leveraging an unexplored approach, which stems from the integration of two different research fields that deal with servitization (i.e. BMI and buyer-supplier relationship for collaborative New Product Development), investigated through the theoretical lenses of knowledge management.

Consequently, the aim of this study is to understand the possible KS dynamics that happen in the service suppliers' involvement for a servitization-driven BMI in manufacturing firms. Using a KS theoretical perspective to address the suppliers' involvement in the servitization context, we first bridge these two fields in a conceptual framework, and then we apply it in the analysis of a multiple case study on seven multinational companies in order to deepen the understanding of this phenomenon. Therefore, we explore the relationship between several differences concepts: we first classify product-service systems (PSS) offering into two different BMI orientations for servitization (product or service orientation) and then we relate such classification to three different types of NPD supplier involvement (black, grey and white box). Finally, the dynamics of KS in these different combinations is studied based on three main levels of KS: transfer, translation and transformation. As a result, we present a final theoretical framework for KS dynamics between the manufacturing companies and their service suppliers.

The main research contribution from this work is that the proposed framework reveals different KS dynamics and intensities that can happen between the manufacturer and the service supplier, as well as it explains how the KS dynamics are affected by the type of collaboration and the strategic orientation of the servitization orientation adopted by the company. We show that, by integrating these perspectives, it is possible to obtain a more fine-grained description about the levels of KS among the involved actors. We also discuss

different servitization strategies manufacturing companies may want to pursue, based on speed of implementation and level of dependency on service suppliers. In this sense, while some types of collaboration and BMI orientation will require higher levels of KS, resulting in the development of internal service capabilities in the manufacturing company, other configurations could be more appropriate for a faster implementation of servitization or for a less risky BMI. Therefore, different configurations of BMI and suppliers' involvement are discussed in our results.

2 Theoretical background

2.1 Servitization as a manufacturing business model innovation

The servitization strategy consists in an integration process of products and services into a system – widely named as Product-Service System (PSS). It requires a new form of organizing the manufacturing company and its stakeholders to provide functionality to consumers (BEUREN; GOMES FERREIRA; CAUCHICK MIGUEL, 2013; MANZINI; VEZZOLI, 2003). Therefore, it is considered as a BMI in the context of the traditional product development and manufacturing system (CESCHIN, 2013; VISNJIC; WIENGARTEN; NEELY, 2016). A company can target different levels of PSS in the servitization strategy (BIKFALVI et al., 2013). Consequently, the BM can undergo different degrees of transformation, from incremental BMI, where the central value proposition (i.e. the BM's "what and why" according to Mitchell and Coles, 2004) does not change dramatically (although other BM components may vary), to radical BMI, where the value architecture changes significantly (CORTIMIGLIA; GHEZZI; FRANK, 2016; TEECE, 2010). At initial levels (i.e. incremental BMI), the company offers the core product and also some related services such as logistics and distribution, installation and commissioning, maintenance and upgrades, personal support and training (DURUGBO, 2014; WANG; LAN; JIANG, 2016). A more radical level of BMI (i.e. a deeper level of BM transformation) implies that the company will offer the product itself as a service, such as Rolls-Royce's offering of 'power-by-the-hour' instead of selling aero-engines (BAINES et al., 2007).

Particularly, in this study we are considering manufacturing companies that keep their competence in technology, product development and manufacturing, and need to change the way such products are offered and commercialized. These companies might not want to abort their manufacturing activities, but need to transform how they offer their products and how they deal with customers – which are both key parameters of a BM (e.g., see

MITCHELL and COLES, 2004). Following Galbraith (2002) and Matthyssens and Vandenbempt (2010), a manufacturing company may choose between two main BMI orientations in their servitization strategy: (i) a product-oriented PSS, where changes are incremental the PSS design is more focused on finding as many uses as possible for the company's products, and services are developed to improve or boost product utilization, e.g. maintenance, spare parts, upgrades, project engineering; or (ii) a service-oriented PSS, where changes are more radical and the PSS design is more customer-centered, i.e. more concerned with customer needs than with sales of products, which implies thinking about new solutions for customers which may not be restricted to products currently offered.

2.2 Knowledge sharing perspective for the involvement of service suppliers

The manufacturing company can offer different levels of PSS in the servitization strategy adopted. However, the more complex the PSS is, the greater the gap between what the company knows and what it really needs to offer the solution will be (CHIRUMALLA, 2013; LEONI, 2015; PAWAR; BELTAGUI; RIEDEL, 2009). Such knowledge gap can be approached and diminished with the support of service suppliers (DAVIES, 2004; KINDSTRÖM et al., 2015). In some cases, while the product is provided by one organization, the service component can be exclusively supported by a partner (MARTINEZ et al., 2010; WINDAHL; LAKEMOND, 2006), but other combinations and joint PSS development are also possible where different KS is needed among partners.

KS is considered as a process comprising two main actions: (i) the knowledge movement from a source to a recipient, and (ii) its subsequent absorption and use, taking advantage of previous experience (FRANK; RIBEIRO; ECHEVESTE, 2015). In our case, the sources are the service suppliers who hold relevant service knowledge for the business, and the recipient is the company's manufacturing business unit that is innovating its BM supporting a servitization strategy. From the different existing perspectives of KS (e.g. FRANK; RIBEIRO, 2012; HOOFF; HUYSMAN, 2009), in this study we adopt Carlile's (2004) 3-T model. We also adopt the term KS instead of knowledge transfer to refer to knowledge moving between source and recipient, using a social perspective between actors (FRANK; RIBEIRO, 2012; HOOFF; HUYSMAN, 2009). We adopt this perspective following the same point of view of the conceptual framework for NPD collaboration proposed by Le Dain and Merminod (2004), which is used for our case study analysis. As observed in Figure 3, Carlile's (2004) 3-T model distinguishes three levels of KS complexity

across boundaries between actors involved in an innovation process: *transfer*, *translation* and *transformation*.

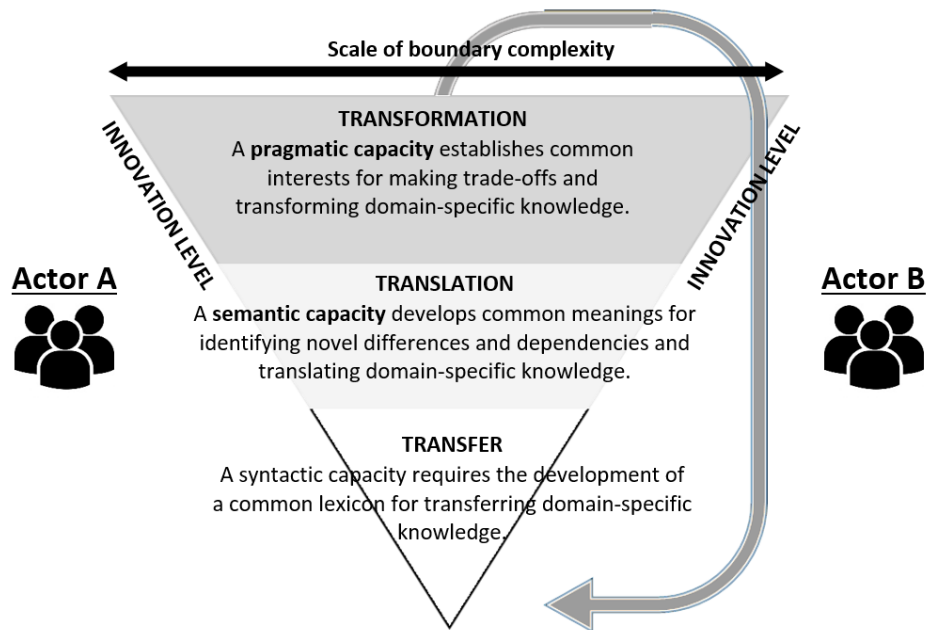


Figure 3 – 3-T framework to manage knowledge across boundaries

(Source: Adapted from Carlile, 2004)

The 3-Ts (*transfer*, *translation* and *transformation*) of Carlile's (2004) model are related hierarchically. According to the level of innovation, the actors will move up and down through the different levels of cross-knowledge complexity. Then, when the innovation level increases, knowledge transfer is necessary for the knowledge translation while the knowledge transformation process requires both transferring and translation; thus, the transfer knowledge process is at the basis of the framework. The loop in Figure 3 indicates that, because of the complexity, managing knowledge across a pragmatic boundary cannot be resolved with just one attempt: it requires multiple iterations. During the interaction of sharing and assessing knowledge, the actors will create new agreements and will make changes, developing a common lexicon, with shared meanings and interests to access knowledge across the boundary (CARLILE, 2004; LE DAIN; MERMINOD, 2014). In the following sections, we discuss in detail the meaning of each of these three levels of KS.

2.2.1 Knowledge Transfer

In this first level of KS – *transfer of knowledge* – knowledge is considered external, explicit and storable. In this case, knowledge can be transferred mainly using information

processing tools, e.g. the implementation of a product data management system that provides a common workspace where product data can be shared (CARLILE, 2004; LE DAIN; MERMINOD, 2014). At the knowledge transfer level, the primary concern is about the syntactic capacity needed to develop a common lexicon that can be used to cross the boundary. If the level of innovation increases, merely transferring knowledge is not enough anymore because the current lexicon is no longer sufficient to represent the differences and dependencies (CARLILE, 2004). In practice, knowledge transfer can be identified when an exchange of boundary objects between the actors occurs. Boundary objects are objects or documents that are created and used during collaborative activities, e.g. requirement specifications and timelines, prototypes, design drawings and e-mails (CARLILE, 2004; LE DAIN; MERMINOD, 2014).

2.2.2 Knowledge Translation

According to Carlile (2004), when the level of innovation grows, the complexity of KS increases and a transition is needed from a syntactic to a semantic or interpretative boundary, since some differences and dependencies become unclear and some meanings can be ambiguous. In this level, called *knowledge translation*, the complexity of knowledge naturally generates different interpretations, thus making it necessary to use mechanisms to create a shared meaning between actors in order to cross this new boundary. The creation of common meanings can become more than just a translation process; it can be a negotiation process of interests between actors that could result in a learning cost for some stakeholders. In practice, knowledge translation can be identified when there is a discussion between actors to avoid knowledge misunderstanding (CARLILE, 2004; LE DAIN; MERMINOD, 2014).

2.2.3 Knowledge Transformation

Finally, in the highest level of innovation, there is a transition from a semantic to a pragmatic boundary, where a solution has to be found for divergent actor interests. In this process, actors not only have the learning cost of accepting a new knowledge, but they have to transform their existing domain-specific knowledge, and even the common knowledge, to be able to effectively share and assess knowledge at the boundary (CARLILE, 2004). This stage is called *knowledge transformation* and is the most complex boundary, because the cost of transforming current knowledge can negatively affect the willingness of the actor to make the necessary changes. In practice, knowledge transformation activity can be identified when a

complex problem-solving situation occurs during a project and it results in the building of a new solution (CARLILE, 2004; LE DAIN; MERMINOD, 2014).

2.3 Buyer-supplier integration approach to study KS in service suppliers' involvement

Buyer-supplier integration is a core topic in the new product development (NPD) literature, where there is concern about how to develop product solutions together with those suppliers that detain knowledge about materials and technologies which is complementary to what the main company knows (KOUFTEROS; EDWIN CHENG; LAI, 2007; RAGATZ; HANDFIELD; PETERSEN, 2002).

Petersen et al. (2005) argue that the inter-organizational relationship between suppliers and buyers during an innovation process may be divided in three configuration levels, according to the supplier's involvement: (i) White Box (design is buyer-driven), (ii) Grey Box (joint design) and (iii) Black Box (design is supplier-driven). In the *White Box* level, the buyer is responsible for the whole design and specification of the solution and the supplier is mainly involved in the late project stage, commonly the execution stage. In the second level of buyer-supplier integration, the *Grey Box* configuration, the design solution activity is strongly integrated and none of the stakeholders has all the necessary knowledge; therefore, both supplier and buyer have the same level of responsibility and importance in the design. Consequently, stakeholders and buyer work in deep collaboration from the beginning of the project until the execution phase. Finally, in the *Black Box* configuration, the major responsibility falls on the supplier, who is in charge of both designing and executing the solution based on buyer's requirements and specifications. In this configuration, the buyer provides the functional requisites at the beginning of the project and the supplier uses its expertise to interact with the buyer in order to clarify needs and to develop the adequate solution (LE DAIN; MERMINOD, 2014; PETERSEN; HANDFIELD; RAGATZ, 2005).

Studying the supplier' involvement in the collaborative NPD context, Le Dain and Merminod (2014) operationalized Carlile's (2004) framework by investigating how such KS framework explains the three types of supplier's involvement configuration. Le Dain and Merminod (2014) demonstrated that the dynamic of KS varies according to the supplier's involvement configuration, as illustrated in Figure 4. According to their results, the White Box configuration mainly consists in transferring knowledge, but this potentially generates knowledge translation to enable process capabilities and requirements to be integrated into the

product design. The Grey Box configuration requires high knowledge transfer, translation and transformation and the process has a cyclical dynamic. In the Black Box configuration, a high knowledge transfer, substantial knowledge translation and medium knowledge transformation during the design phases to clearly define specifications are required, though, differently from the White Box configuration, in this case knowledge transfer calls for knowledge translation.

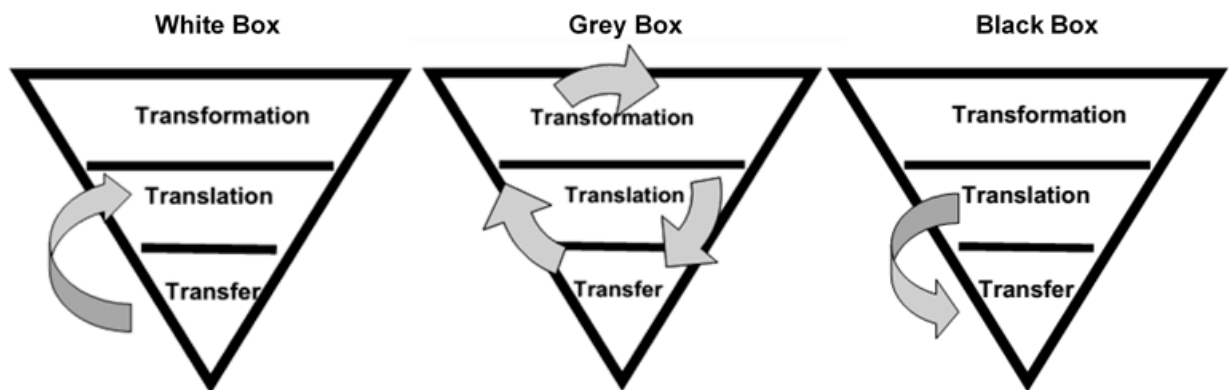


Figure 4 – Knowledge sharing dynamics for White, Grey and Black Box supplier's involvement configuration in collaborative NPD according to Le Dain and Merminod (2014)

Several authors stress the importance of knowledge management in the process of BMI for servitization (e.g. BELAL; SHIRAHADA; KOSAKA, 2012; CHIRUMALLA, 2013; HAKANEN, 2014; JIANG; LI; LI, 2011; LEONI, 2015). Therefore, as the most intensive KS in servitization happens between business units and their service suppliers, it becomes imperative to profoundly analyze this specific relationship and the possible ways of interaction (MARTINEZ et al., 2010; WINDAHL; LAKEMON, 2006). Thus, we propose to adapt this understanding of KS activities in different types of NPD supplier's involvement to the context of BMI for servitization, as discussed in the following section.

2.4 Adapted framework for the innovation of solution business models

In the light of the theoretical background discussed, our study proposes to adapt the Le Dain and Merminod's (2014) framework to the relationship between a manufacturing company and its service suppliers in the context of BMI for servitization. We assume that this adaptation may be valuable for three reasons. First, servitization requires an involvement of external agents that implies to bring in external knowledge so as to integrate the internal one, similarly to what happens in the buyer-supplier integration in NPD (MARTINEZ et al., 2010; WINDAHL; LAKEMON, 2006). Second, the level of servitization chosen by the company

can lead to different levels of complexity in BMI (BIKFALVI et al., 2013) and, consequently, to different levels of relationship with the service suppliers (FINNE; HOLMSTRÖM, 2013), resulting in different configurations of such relationship – i.e. White, Grey and Black Box configurations. Third, in line with what happens in buyer-supplier integration, there is a need to understand the different KS dynamics that can occur for different configurations of service suppliers' relationship during the servitization-driven BMI (BASTL et al., 2012; JOHNSON; MENA, 2008). Therefore, we propose an adapted framework by joining the traditional research stream of buyer-supplier relationship in NPD to the recent research field of BMI for servitization.

Figure 3 introduces the conceptual framework that will guide our case study analysis. Following the BM orientation adapted from Galbraith (2002) and Matthyssens and Vandenbempt (2010) (as discussed in Section 2.1), we propose a classification of servitization-driven BMI into two main levels of value offering: (i) product-oriented PSS, where the tangible good is the most important part of the PSS offering and only goes through limited changes to complete the solution package, being service the most flexible part; and (ii) service-oriented PSS, where the service becomes the central aspect of the value-proposition for customers and the product can be flexible and adapted according to the service offering. In other words, the product-oriented classification is a pushed-process, where the product usage triggers the opportunity to add new services to become more valuable for customers. In contrast, the service-oriented classification is a pulled-process, since new service opportunities for customers are the trigger for the creation of a servitized solution, similarly to the market-pull innovation concept (ROTHWELL, 1994). Additionally, in Figure 5 we propose that both BMI orientations for servitization can present different configurations of suppliers' involvement (as explained in Section 2.3). In this sense, we followed Petersen's et al. (2005) supplier's involvement configuration. As a result, in each intersection between the BMI for servitization and the types of service suppliers' involvement, we aim to collect data from the manufacturing companies studied regarding the integration modes, i.e. how integration happens between the company and the service suppliers; and, especially, we aim to understand how KS happens regarding the KS levels of Carlile (2004) previously treated in Section 2.2.

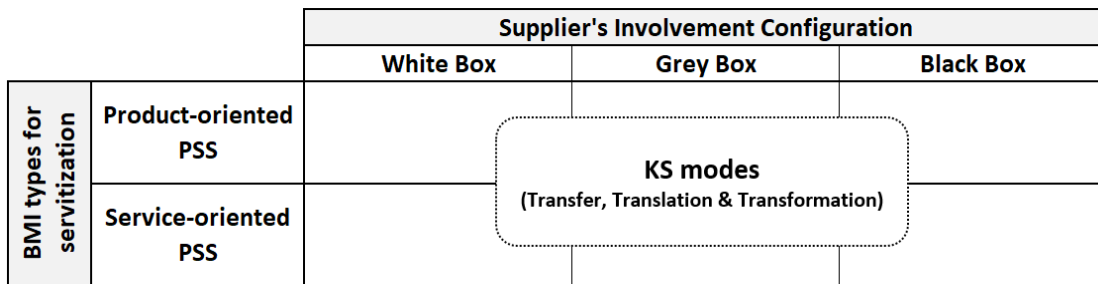


Figure 5 – Conceptual framework: KS modes in different configuration of servitization-driven BMI and service suppliers' involvement

3 Research Method

We adopted an empirical case study research approach based on qualitative data collection and analysis (YIN, 2009). We choose this research approach because it is useful for theory building based on a deep analysis of the field (EISENHARDT; GRAEBNER, 2007; YIN, 2009). We selected a multiple-case approach rather than single-case analysis to augment external validity and to reduce the potential observer's bias (VOSS; TSIKRIKTSIS; FROHLICH, 2002). We employed the proposed conceptual framework (Figure 5) to ground the research and to guide our empirical study. The research design was based in Voss et al. (2002) guidelines, which is described next.

3.1 Case study selection

The cases were selected by means of a theoretical sampling. According to Eisenhardt and Graebner (2007), theoretical sampling means that cases are selected because they are particularly suitable to shed light on constructs. As a first step to identify the companies that could have the requisites to fulfill at least one of the quadrants of our conceptual framework (Figure 5), we considered an ongoing survey on servitization carried out in an industrial research network coordinated by two Universities (Italy and Brazil), and we identified 95 manufacturing companies that affirmed to have a strong collaboration with service suppliers. We selected 39 of them that are large multinational companies (>500 employees) to take firm size and related complexity into account. We scrutinized the companies' profile and made a first telephone or e-mail contact to verify their availability and adequacy to our research propose. We intentionally chose companies from different industries and with different relationships with their service suppliers, aiming to produce contrasting results that can offer a

broader picture on the phenomenon and facilitate the generalization of the results (CESCHIN, 2013; YIN, 2009). On the basis of the information received, we selected seven companies; in two of them, we analyzed two different independent business units, i.e. we chose the company's business units (BU) as unit of analysis. Thus, we obtained nine different cases from seven different companies.

We analyzed servitization at this level because different BUs can have their own BM (CORTIMIGLIA; GHEZZI; FRANK, 2016): therefore, as a potential service supplier we considered either another BU from the same company with independent processes and incomes, or a different company. In both situations, we considered the BU that developed traditionally manufactured products and implemented a servitization-driven BMI as the central BU of analysis; while other BUs or companies focused on service activities were considered the potential service suppliers. In the BUs where the PSS offering follows a service-oriented PSS, i.e. each solution is developed as a customized project for the client, we asked the interviewees to consider the service supplier integration to the most typical PSS offering that is developed. Table 2 provides a brief description of each case study; companies' and respondents' names were changed to preserve anonymity.

Table 2: Background of the cases

Case company	Description	Size	Business Unit analyzed	Data sources	Years in the company
A	German international company from dental/medical sector	+1,000 employees	Brazilian branch	Latin America (LA) CEO	12
				Service development engineer	4
				Service support consultant 1	4
				Service support consultant 2	3
B	US multinational company from the IT industry focused in computer, hardware and IT services	+ 100,000 employees	Computer BU	LA service sales manager	7
				Service solution manager 1	8
			Hardware BU	Service solution manager 2	5
C	Brazilian national company from tailor-made furniture market	+1,000 employees	Headquarters (HQ)	CEO	17
				Supply chain director	14
				Sales manager	8
				Purchasing manager	11
D	Swedish multinational from telecommunications industry.	+ 100,000 employees	Telecom hardware BU	Senior project manager	10
			TV and Media systems BU	Product engineer	3
				Service sales manager	9
E	Swiss multinational from energy and automation industry	+ 140,000 employees	Spanish branch	Senior project manager	12
				Regional service manager	15
				Consultancy engineer	6
F	French multinational from energy industry	+ 150,000 employees	Field Service BU	Service Manager	2
				Company's consultant 1	-
				Company's consultant 2	-
G	US multinational from process and motion control.	+ 8,000 employees	Brazilian branch	Supply chain manager	15
				Purchasing analyst	1
				Sales engineer	4

3.2 Research instruments

As a primary source, we employed semi-structured interviews where we first asked the interviewees to describe their servitization case and the suppliers' integration characteristics. Moreover, to assess the level of intensity of KS (Figure 2) in the BMI for servitization, we followed the scale proposed by Le Dain and Merminod (2014) which consists in counting the numbers of KS situations during the collaboration. For the knowledge transfer level, they propose to measure the intensity as the number of existing Boundary Objects (BOs) (i.e. objects such as documents or models used to support cross-boundary discussion), as well as the number of iterations based on them (i.e. how many times the partners have work jointly on these Bos). Knowledge translation can be measured as the number of situations (meetings) needed to prevent sticky knowledge misunderstanding and

the number of project members associated with the situations. Finally, knowledge transformation can be measured as the number of complex problem-solving situations encountered during a project and the duration to solve these problems.

Since we have had no access to the information system of the nine companies to obtain the quantitative data on KS intensities, as Le Dain and Merminod (2014), we adapted the use of this scale by asking the interviewees to assess qualitatively the KS intensities using the counting scale as a reference (see Table 3). Moreover, we asked them to give arguments and examples to support their estimations about these levels and this information was still contrasted with other qualitative descriptions they made during the interview. When any discrepancy was identified, we used the second interviews round to clarify such differences and achieve a consolidated understanding about the KS levels. A first version of the research protocol, composed by the questionnaire and the KS scale, was pretested with five researchers from our research group and one experienced manager of a manufacturing company. Moreover, a first interview round in Company D was used as a pilot for the research protocol. We then improved our research protocol (by rephrasing questions that were not clear to the interviewees) and we performed again a second round of interview with this company.

Table 3: Indicative scale to measure the level of intensity of knowledge sharing.

(Source: adapted from Le Dain and Merminod, 2014)

Concept	Variable	Measure (orientation for interviews)	Intensity
Knowledge Transfer	Number of boundary objects (BOs) exchanged: e.g. documents, e-mails, specifications, prototypes, drawings.	- Limited number of BO: < 50 BOs and Limited iterations on BOs (<3 versions in average per BO)	Limited
		- Limited number of BO: <50 BO and numerous iterations on BOs (>3 versions in average per BO) OR high number of BO: >50 and Limited iterations on BOs (<3 versions in average per BO)	Medium
		- High number of BO: >50 and Numerous iterations on BOs (>3 versions in average per BO)	High
Knowledge Translation	Number of situations where efforts are made to avoid sticky knowledge misunderstandings.	- Limited situations to avoid sticky knowledge: <5 and Limited participation of project members (Engineering & Service)	Limited
		- Limited situations to avoid sticky knowledge: <5 and High participation of project members (all or almost all project members) OR Numerous situations to avoid sticky knowledge: >5 and Limited participation of project members.	Medium
		- Numerous situations to avoid sticky knowledge: >5 and High participation of project members (all or almost all project members)	High
Knowledge Transformation	Number of complex problem solving situations which result in the building of a new solution	- Limited number of complex problem solving situations: <5 and problem solved quickly	Limited
		- Limited number of complex problem solving situations: <5 and short problem solving duration OR numerous number of complex problem solving situations: >4 and long problem solving duration	Medium
		- Numerous number of complex problem solving situations:>5 and long problem solving duration	High

3.3 Data collection

For data collection, we used different sources of information to improve reliability of our analysis (Yin, 2009). Specifically, to enhance reliability of data collected from interviews, we interviewed at least three persons that participated directly; in the development of the PSS offering, such as key managers and product, project and service engineers (see Table 2). In all cases, we collected data from the main company side, and this company provided us with information about its suppliers. We did not collect data from suppliers, since the access to them was restricted by the companies because of the strategic and sensitive nature of the information required. Due the complexity of the information demanded, some days before the interview we sent an outline of the research protocol to interviewees, so that they could be prepared and also collect the documentation to support their statements (VOSS; TSIKRIKTSIS; FROHLICH, 2002). The average time of each interview meeting was around two hours. In two cases, the interviews were made by videoconference. During data collection, we used an audio recorder and written notes to record the impressions and comments from participants. The notes were taken by three researchers, two are authors of this paper and the third is a research assistant: such approach helped to confront impressions

from each researcher during the interviews, allowing to obtain a more complete view of each case and also help reducing observers' bias (YIN, 2009). After analyzing the interviews' transcription, we conducted a new round of interviews to the same respondents, aiming to clarify details or questions that remained from the first round. To allow data triangulation, we reviewed companies' documents (mainly internal procedures, business reports and internal slides presentations), information from newspapers and websites (especially to better understand the business activities and new products offered by the company) and scientific papers of other case studies conducted in the same companies (only available for two of the studied companies). The whole process of data collection was conducted from March to August 2015.

3.4 Validity and reliability

As for construct validity, concerning the correct operational measurement of the concepts, we used multiple sources of evidence and followed the indicative scale presented in Table 3 and the list of boundary objects presented by Le Dain and Merminod (2014). In terms of external validity, we conducted the multiple case study and compared evidences on a selection of large companies that traditionally had a manufacturing BM and that recently changed to a BM focused on servitization. Finally, concerning reliability, we used a case study protocol and a final report was developed based on the transcription of the recorded interviews and observations. Some of these procedures were described in Sections 3.1. to 3.3.

3.5 Data analysis

As a first step for the data analysis, the recorded interviews were literally transcribed by the research assistant. After the transcription of all interviews from the same case study was completed, several meetings were conducted between the three researchers involved in the data collection to extract all information from the notes, audio recordings and collected documents. The data was analyzed seeking for evidence from each type of knowledge sharing from Carlile's (2004) 3-T model (Figure 3). The KS levels were analyzed based on the criteria established in Table 3, which was used during the interviews. We also reinforced the interviewees' assessment of Table 3 by analyzing the recorded comments and examples given by them to illustrate each evaluation; this was made by applying open coding techniques. These evidences were structured and organized in a final report for each case study. A second

round of interviews was conducted to present the report conclusions to the interviewees and to collect feedbacks on our interpretation as well as new information for the cases when convergence was not reached.

After we individually analyzed each case and identified isolated factors and behaviors, we also performed a cross-case analysis to recognize similarities, contrasts and patterns among cases. Finally, we contrasted the results of the cross-case analysis with the literature and we developed a final theoretical framework.

4 Results

Table 4 shows the companies' distribution according to our conceptual framework presented in Figure 5. Some of the companies are repeated in different cells, since these are cases where we considered two different BUs from the same company. These cases are differentiated with an additional letter into brackets. In the next subsections we describe each combination.

Table 4: Companies distribution according to the proposed framework

	Types of service suppliers' involvement		
	White	Grey	Black
BMI for Product-oriented PSS	Company A [Dental care equipment]	Company D[1] [Telecom hardware]	Company D[2] [TV & Media systems]
	Company B[1] [IT infrastructure]		
BMI for Service-oriented PSS	Company C [Furniture]	Company E [Automation]	Company G [Motion systems]
		Company F [Energy]	Company B[2] [Hardware]

Note: Letters into brackets [1] [2] corresponds to different business units from the same company

4.1 White Box configuration

The White Box configuration in our context of study refers to companies that design almost all PSS offering alone and include the suppliers to collaborate just in the execution phase. Next, we described the White Box cases.

4.1.1 Servitization-driven BMI for product-oriented PSS

4.1.1.1 Dental scanner (Company A)

Company A is one of the global leaders in equipment and diagnosis systems for dental care. In its early years, it was only focused on the development of new products in its R&D department located in the German Headquarter. Aiming to enter in the Brazilian emerging market, the company first tried to operate by means of national distributors. However, the company realized that there was a strong barrier to enter in this market, since the clients' needs were different from the traditional markets where the company used to operate. This is because the equipment users in Brazil are not generally dentists, as in the European market, but radiology technicians from image diagnosis centers. Single dentists are not capable to afford this imported product; therefore, the image diagnosis centers take on such kind of diagnosis by concentrating high levels of demands that justify the investment in such equipment.

Company A started a project to develop a service offering to adapt its dental scanner equipment to the Brazilian market. Services were conceived to be the flexible part necessary to adjust the product to a new way of use and for other kinds of operators. First, this PSS offering is classified as a servitization-driven BMI focused on product-oriented PSS because the equipment did not undergo any change, but the company provided a software service, offered as an additional package through a license of use, which helps to make the equipment user-friendly for the new applications and users. Second, this PSS offering is classified as a White Box because Company A designed all the requirements of this additional service; the software company was involved only at the last stage. As the CEO affirmed: *"I spent almost five months visiting our Brazilian clients to understand how they really use our product. [...] Since there was only one person in the German HQ that had the knowledge – but not the time – to develop the software, we prospected a regional company to develop it according to our specifications"*. So, the company established a partnership with a software development company to outsource this development and to provide support during the use of this service.

Referring to KS dynamics, the interviewees agreed that a high level of knowledge transfer was necessary between them and the software company. The interviewees presented several evidences of boundary objects used during the PSS development, such as: contracts, documents with specifications of product and service, software prototypes to test the user-friendly interface, draft of the layout to print radiographies from different patients in the same radiography sheet and several e-mails interchanged between actors to clarify little details of

software functionalities. About knowledge translation, it was classified as a medium intensity, because even when numerous situations to clarify misunderstandings were necessary, Company A had a low participation during the software development. As the service development engineer from the supplier affirmed: *“we [the software development team] had a hard time at the beginning to understand what they [Company A] needed [...]. We had several meetings at the beginning, but after that, a routine of weekly meetings with Company A was enough”*.

4.1.1.2 IT infrastructure (Company B)

The second case study was conducted in Company B. We named it Company B[1] because two cases were conducted in the same company. Traditionally, Company B was a computer manufacturer company, but by the end of the 2000s the company decided to innovate its BM by increasing its focus on computer services offering (which today represents approximately 15% of the total revenues). In the PSS offering analyzed, the products were mainly hardware, such as computers and data centers, and the services included in the PSS were mainly restricted to some standardized services. Typically, these services are focused on putting the new system online (e.g. configuration, logistics and data migration) and providing Information Technology (IT) professional services (e.g. consulting for companies' IT optimization or modernization), which are directly related to the equipment selling. Therefore, this BMI was classified as a product-oriented PSS, since the services are adapted to the product, but the product itself does not suffer modifications. The offered services are sold jointly with the products, as additional licenses and services for a complete care of the IT infrastructure.

This PSS offering was classified as a White Box because all services were developed internally by Company B[1] and service suppliers were involved just in the execution phase. Comparing with case A, this does not happen because of the lack of competence, since in some situations, depending on the geographical location, Company B executes also the service offer by itself. However, in this case the company adopted this strategy aiming to reduce the risk regarding the possibility of losing focus on its core business, which is still the IT infrastructure, as well as to reduce the complexity that involves managing a large number of service technicians dispersed around the world.

Regarding KS, the interviewees agreed that most of the information is shared by a high volume of documents (e.g. hardware and service specifications, manuals, catalogues, training materials, contracts) that are available in a specific internal platform. As the Service

Solution Manager 2 affirmed: “[...] *they [service suppliers] have access to our internal platform which is ‘full’ of specifications about our products [...] Commonly, the documents in the platform are enough to support them, but sometimes we have some specialists that receive calls from the technicians when they have some problem*”. The interviewees self-assessed their level of knowledge translation as moderated because, additionally to the phone calls, it is mandatory that technical employees from the partner company attend a training course given by Company B to avoid misunderstanding of service and hardware specifications and to guarantee the brand quality standards.

4.1.2 Servitization-driven BMI for service-oriented PSS

4.1.2.1 Customized furniture (Company C)

Traditionally, Company C developed and manufactured off-the-shelf furniture, but in the last decade it engaged in a BMI transition towards customized products, which was the focus of our case study. In the first BMI stage, the company stopped producing furniture in large-scales and focused more on value-added products. In this sense, they changed to a concept of modular design that allows a flexible building of the furniture, according to the clients’ demand (customized products). They invested in front-end activities, such as proprietary stores and trained personnel for furniture design (i.e. employees were trained in the use of software that allows the adaptation of the modules available). However, the company advanced even further: In the second BMI stage, five years ago, the company fully focused on a servitization strategy. They started offering an integrated solution for clients based on a long-term service of “furniture update” program. This service consists in the modular furniture concept previously used, but then focused on a constant adaptation of the purchased furniture, changing it according to customers’ family evolution with low cost for adaptation.

This case study was classified as a White Box collaboration because the service suppliers were included only at the final phase. Both service and product are designed by the company and the adaptation service is executed by services companies through outsourcing. Differently from both cases A and B[1], in this PSS offering the product is flexible and can be adapted to the customers’ needs, i.e. a service-oriented PSS is designed.

According to the interviewees, the level of knowledge transfer is high since a lot of information is exchanged with partners in written format – mainly contracts, product and service specifications, assemble instructions, client history and e-mails. Additionally,

interviewees' self-assessment pointed out a high level of knowledge translation, claiming that they held many meetings with partners to discuss service characteristics and quality patterns. Moreover, they also performed advanced training programs to qualify the service suppliers for a correct execution of services. As the CEO affirmed: *“there are hundreds of furniture companies, [...] our differential is the service that we offer [...]. During the first semester with us [referring to the service supplier], one supervisor of our company supported most of the service execution [...]; this condition is included in the contract they signed”*.

4.1.3 Cross case analysis of White Box cases

As shown above, the three cases conform to a White Box configuration because the service providers were included just in the late project phase, where all specifications were already defined by the manufacturing company. Regarding KS assessment by the interviewees, following Carlile's (2004) classification and Le Dain and Merminod's (2014) scale, KS mainly consists in a high knowledge transfer activity, which can be identified in the intensive exchange of e-mails, manufacturing and services contracts, contractual specifications, manuals and equipment specification, service specification and training materials, among others. However, while similar levels of knowledge transfer were perceived by all interviewees, different levels of knowledge translating emerged according to the companies' BMI focus on servitization. On the one hand, Company C, which experienced a BMI for service-oriented PSS, declared high levels of knowledge translation, which is explained by the fact that this company completely designs the PSS offering where the service is the most important part of the value proposition (solution). Therefore, Company C has to assure the suppliers' understanding about how the service should be provided. On the other hand, Companies A and B[1], which innovated their BM for a product-oriented PSS, showed moderate levels of knowledge translation, since the dominant part of the solution is the tangible good, which can be well defined only by specifications (knowledge transfer). Therefore, based on this first configuration of buyer-supplier integration aiming at servitization-driven BMI, we introduce the following two propositions:

Proposition 1: *White Box collaboration for servitization-driven BMI aiming at a product-oriented PSS requires high intensity of knowledge transfer and moderate intensity of knowledge translation during the knowledge sharing dynamic between buyer and supplier.*

Proposition 2: *White Box collaboration for servitization-driven BMI aiming at a service-oriented PSS requires high intensity of knowledge transfer as well as high intensity of knowledge translation during the knowledge sharing dynamic between buyer and supplier.*

4.2 Grey Box configuration

The Grey Box configuration refers to companies that conduct their servitization-driven BMI through a strong relationship with suppliers by co-designing the central parts of the product-service solution; that is, suppliers are not involved only in the execution phase as in the White Box configuration. Next, we describe the cases representing this configuration.

4.2.1 Servitization-driven BMI for product-oriented PSS

4.2.1.1 Telecom Hardware (Company D)

Company D is traditionally dedicated to the telecommunication industry. In this company we analyzed two different PSS offerings developed with service suppliers: one developed in the company's BU dedicated to telecommunication hardware development and manufacturing, here called Company D[1]; and another in the company's BU dedicated to the development of TV & Media systems, here named Company D[2]. In this section we analyzed the first one.

Company D[1] in the early 2000 had a portfolio composed by around 30% of service and 70% of hardware profits. Thus, this BU had a hardware-driven BM. However, over the last 15 years the company portfolio has been shifting to a service-driven BM, with almost 70% of the profits coming from service offer. Nonetheless, even now that the main profits come from services, these services are adapted according to the already defined product project and, thus, this BU is classified as a BMI focused on product-oriented PSS. The company's changes originated from a necessity of its telecom operator partners which, because of the complexity of this industry, asked for services to rapidly respond to market evolution and support their business shift from network centric to customer centric.

As exposed by interviewees, and also supported by public available reports and some internal documents presented by the management, Company D[1] opted to establish a partnership with some small and medium service companies to satisfy a new demand. As the service sales manager affirmed: *"we were the best in developing hardware and sell it 'as a box', but our client started to demand for complex solutions [...]. We were a slow giant, [...]"*

without partnerships it would not have been possible to catch up with market speed". So, they developed together a solution to take full responsibility for the Telco's network, including planning, design and implementation, daily operations and maintenance. Since the interviewees affirm that no two operators are alike, the customized solutions for the client are designed jointly, i.e. representatives from both sides are included in the team in charge of being in contact with the client during the design phase. After this phase, the service companies are predominantly in contact with the client and the service is controlled by a Service Level Agreement (SLA) based on performance indicators. When the client's requirements are already identified, there is a joint discussion between the partners about which PSS offering may better satisfy the clients. However, this discussion has the limitation that there is no possibility to modify the hardware already developed by Company D[1], which indicates a BMI focused on product-oriented PSS. Hence, the solution is restricted to the field of the already existing hardware applications. As the senior project manager expressed: *"the manufacturing way of thinking is still in our veins [...], our R&D develops the new products and our customer unit [i.e. service supplier] has to do a big effort to fit the service into the package"*.

According to the interviewees, a high volume of written information is exchanged between the BUs, e.g. client's characteristics, client's network utilization documents, specification of service performance indicator, contracts and hardware specifications, among others. Interviewees agree that there is a high intensity of knowledge translation with service suppliers, as reflected by a senior project manager's statement: *"before, our project managers were used to promise a solution to our clients without really knowing how it would be delivered, and this led to high losses in our markup [...]. Now, we send to the customers a team composed by hardware engineers, service engineers and project managers from both companies to define the solution"*. Because of its high interdependency, this team works jointly during the whole project.

4.2.2 Servitization-driven BMI for service-oriented PSS

4.2.2.1 Robot monitoring (Company E)

Company E is a leading company in automation for manufacturing. The company develops and manufactures robotic solutions for many industries (e.g. assembly lines or processing operations). In this traditional approach, the product was offered off-the-shelf and the clients only chose some configurations based on what they thought they needed. However,

in the last decade, the company set the goal of increasing services revenues by 25% in its global portfolio. One of the initiatives launched was the industrial robot monitoring service, which allowed companies to remotely monitor the status of their robots. Therefore, Company E established a partnership with an Information and Communication Technology (ICT) company to install sensors and modems in the robots and to provide knowledge about data analysis that allows processing information to design, among others, a preventive maintenance program. Both companies worked together for the design and implementation of the solution, thus configuring a Grey Box supplier involvement.

Interviewees indicated high intensity of all types of knowledge sharing. Differently from prior case studies, also high knowledge transformation was indicated by the interviewees. As the regional service manager said: *“a special team of expert engineers was created to analyze market demands [...]; they realized that our company did not have all the expertise to leverage this new trend”*. This new knowledge was created with the ICT partner, as explained by the senior project manager: *“we have a strong expertise in automation [...]; they [ICT partner] know a lot about sensors and Internet of Things”*. New products and even a new BU were created to support the development of this PSS offering, indicating a service-oriented BMI and a high intensity of knowledge transformation. To develop this new solution, interviewees declared that both companies exchanged a significant amount of written information about product specifications, client contract and specifications, client’s maintenance programs and service characteristics. Referring to knowledge translation, interviewees support their self-assessment arguing that both companies had very specific knowledge and several meetings between project members were necessary to define what parts had to be monitored and why, how it would be done and, additionally, what data would be important to obtain.

4.2.2.2 Energy solutions (Company F)

Company F was traditionally a developer and manufacturer of electrical devices and components, such as circuit breakers, transformers, power systems, among other electrical equipment. The BMI changing to a servitization approach was defined in late 2010, in order to satisfy growing clients’ needs to move from buying only energy equipment to purchasing energy solutions. As a result, today services account for around 20% of the company’s revenues. The PSS offering which was the focus of our case study comprised the creation of a stand-alone service BU, named Solution Center, that now offers energy solutions such as engineering studies, field services, projects and modernization, efficiency and sustainability

for energy use, among others. Particularly, since the PSS offering to provide energy solutions differs significantly from one client to another, we asked to the interviewees to refer to the most common situation they face. In this kind of project, the service BU is responsible for requirements definition with the client, installation, assembly and service support, while the engineering BU – the company’s traditional core activity – is responsible for the provisioning of advanced technical support, i.e. the knowledge of internal product characteristics, engineering project and, whenever needed, the outsourcing of civil constructions. Since both BUs and the other partners need to be involved during all design and implementation phases because their specific knowledge, this is considered a Grey Box configuration.

This BMI can be categorized as a service-oriented PSS because the solutions offered are not restricted to Company F’s products, as the service manager’s affirmed: *“our clients ask for energy solutions [...]. If I need to buy some equipment from my competitors to deliver a complete solution, I do it!”*. Because of the complexity needed to deliver solutions that are not restricted to a product portfolio, the interviewees considered that there is high intensity of knowledge transformation in each project. This is illustrated in the words of the service manager: *“each new project is a challenge [...]; it is very rare that we know all details at the starting point [...]; we all learn from the specific situations that occur during the project”*. Also, knowledge translation was assessed by interviewees as high intensity, supported by the fact that engineers of all companies work collaboratively during all project phases, which are coordinated by a project manager from Company F. Finally, a high intensity of knowledge transfer is reflected by the amount of information interchanged between actors, such as contracts, products specification, manuals, standard procedures and even internal forums.

4.2.3 Cross-case analysis of the Grey Box cases

In all cases, the partners collaborate significantly to provide a joint specific solution for the clients, but they also maintain independent traditional business activities. In the three cases, interviewees declared a high level of knowledge transfer (e.g. product and service specifications, documents, e-mails), and also high level of knowledge translation (e.g. very frequent discussions to avoid misunderstanding about how services and product may perform). Finally, knowledge transformation could be observed only in Companies E and F (service-oriented PSS), but not in Company D[1] (product-oriented PSS). Concerning D[1], this behavior can be explained by its focus on product: since the solution design is restricted to the characteristics of the hardware already developed, there are no innovative solutions

created that may demand significant intensities of interpretation and building of common meanings among actors (knowledge transformation). In this case, both sides need to understand the meanings and limitations of both product and service (translation), but the product side does need to go further in terms of unlearning process and new knowledge creation regarding the product. The contrary happens in Companies E and F: given their BMI for service-oriented PSS, the offering is not restricted to the product domain and knowledge transformation can be required in order to rethink the product by adapting it, as well as the service, to a new solution for the client's problem. Finally, it is noteworthy that, in all cases, the interaction among KS levels happens in a cyclical process, until achieving a final solution. Therefore, based on this second configuration of buyer-supplier integration aiming servitization-driven BMI, we introduce the following two propositions:

Proposition 3: *Grey Box collaboration for servitization-driven BMI aiming at a product-oriented PSS requires high intensity of knowledge transfer and translation, in a cyclical process, during the knowledge sharing dynamic between buyer and supplier.*

Proposition 4: *Grey Box collaboration for servitization-driven BMI aiming at a service-oriented PSS requires high intensity of knowledge transfer, translation and transformation, in a cyclical process, during the knowledge sharing dynamic between buyer and supplier.*

4.3 Black Box configuration

For Black Box configuration we refer to manufacturing-based companies that introduce a BMI, changing the BM to a product-service system approach, by outsourcing the service development that will be included in the product-service solution. Next, we describe the cases showing this configuration.

4.3.1 Servitization-driven BMI for product-oriented PSS

4.3.1.1 TV and Media systems (Company D)

For this case study, we analyzed a PSS offering from another business unit of Company D, here named Company D[2]. This BU is dedicated to the development of TV & Media systems. TV and Media is one of the targeted growth areas, which is adjacent to the Telecom core business of Company D. This BU delivers content distribution and services for high-performance video, mobile TV and IPTV consumer services. Company D[2] hence had

to look for service partners to rapidly develop new solutions in the growing video content area, in order to fully exploit its already existing network hardware for this new application. To do this, it established a partnership with some small and medium companies with strong experience in this segment, and even acquired some of them, to create a stand-alone service unit. The engineering team of Company D[2] determined, on a high level, only the main characteristics of the solution that was to be offered with its product, constrained by the already existing hardware that they develop; while the complete service design and offering was executed by the service BU or external partners, thus shaping a Black Box configuration. Moreover, the restriction to the use of existing tangible goods denotes a BMI focused on product-oriented PSS.

As assessed by interviewees, a moderate intensity of knowledge translation was necessary before starting the exchange of written information. Several meetings were necessary between projects managers from the service companies (service BU) and engineers from Company D[2] hardware unit, to understand how existing products could be better used in the TV and Media solutions. As described by the product engineer: *“it was a strategic demand from the top management [...], we were not able to start any project without first understanding what TV & Media means”*. A moderate intensity is also justified by the limited participation of the engineering team in the developing phase of the solution. A high intensity of knowledge transfer was self-assessed by interviewees based on the high volume of documents exchanged, such as contracts, clients’ information, historical records, service specifications, product catalogues and specification as well as e-mails.

4.3.2 Servitization-driven BMI for service-oriented PSS

4.3.2.1 Motion systems (Company G)

Company G is dedicated to Process and Motion Control (e.g. conveying systems, mill chains, steel chains, couplings). In the past, the company was focused only on developing and manufacturing such products, and selling it through dealers. However, because of a clients’ demand and when looking for differentiation from its competitors, the company started to offer customized solutions in complex manufacturing processes where the cost of failure or downtime is high (e.g. beverage and food processes). This BMI is characterized as a service-oriented PSS since the products are developed to allow high solution flexibility. For the solutions development, the company established a partnership between the so-called manufacturing BU and another stand-alone BU dedicated to service offer, named Application

Engineering. The normal way in which the servitized solutions operated is by a first contact of the manufacturing BU with the client, who is looking for a product according to his needs. Then, if the case is complex, the manufacturing BU offers a consultancy project for process and motion improvement. If the client agrees, the service BU is triggered to develop the solution by using the products of the manufacturing BU. Therefore, the service is outsourced, but the client sees the solutions as a package offered by the manufacturing BU, thus determining a Black Box configuration.

According to the interviewees, the intensity of knowledge translation is low: since the products are mainly standardized in simple parts, only a few meetings between manufacturing engineers and service engineers were necessary to the service BU to obtain explanation about some specific product restrictions or applications. As observed by the sales engineer: *“most of the difficulties are in the identification of the necessities of the client, understanding in which environment our product will work and what will be the demand [...]; after the design of the solution, the application engineer will ask for the necessary parts to assemble the solution for the client”*. Following this phase, the largest share of knowledge is exchanged in the form of contracts, products specifications, catalogues and e-mails; according to the interviewees, a high knowledge transfer occurred in the process.

4.3.2.2 IT services (Company B)

In this case study, we analyzed a PSS offering from a second BU of Company B (here called Company B[2]), a computer manufacturer. To expand the service share of its whole solution, Company B[2] looked strategically for others services that could show synergies with its products. To do this, Company B[2] acquired a big company already well established in the IT service market and mainly focused in providing IT services for industries such as healthcare, government and banking. The acquired company has worked as a stand-alone service BU, but following high-level specifications set by the core company. This PSS offering can be classified as a Black Box configuration because the complete solution is designed and delivered by the service BU. Moreover, it is a service-oriented PSS, as affirmed by the Service Solution Manager 1: *“the most complex part of the solution is the service delivered by [the service BU] [...]; they could use hardware from any of our competitors”*.

The interviewees assessed knowledge translation as low intensity. They affirmed that the solution development demands discussions between manufacturing engineers from company B[2] and service managers from the service BU, so as to understand how to obtain a better cooperation between products and services. However, since very simple equipment is

necessary to deploy services, e.g. computers, scanners and servers, just few meetings are necessary. After the meetings held to avoid misunderstanding, the interviewees indicated a high level of knowledge transfer related to the information exchange about product and service specifications, contracts, e-mails, among other writing forms.

4.3.3 Cross-case analysis of the Black Box cases

The three cases are characterized as a Black Box configuration because the design, development and execution of the services are mainly performed by a stand-alone service BU or service supplier. The manufacturing BU only defines some high-level specifications for the services, but at an operational level it is still only concerned with the hardware/product offer and support, while the service is outsourced. Regarding the knowledge sharing dynamic, we observed a high transfer among actors in all the cases, mainly involving product and service specifications, but different levels of knowledge translation. On the one hand, Companies B[2] and G, which conducted a BMI for service-oriented PSS, had shown low knowledge translation, since their products are simpler and standardized. Consequently, the complexity of the solution lays on the service part, which results in a low need of knowledge interpretation by the manufacturing unit. On the other hand, the product-oriented PSS of Company D[2] demands moderate knowledge translation because of the high dependence of the service in the hardware utilization, which requires the service BU to deeply understand the product's characteristics in order to develop the whole solution. Therefore, based on this last buyer-supplier integration configuration aiming servitization-driven BMI, we introduce the following two propositions:

Proposition 5: *Black Box collaboration for servitization-driven BMI aiming at a product-oriented PSS requires high intensity of knowledge transfer and moderate intensity of knowledge translation during the knowledge sharing dynamic between buyer and supplier.*

Proposition 6: *Black Box collaboration for servitization-driven BMI aiming at a service-oriented PSS requires high intensity of knowledge transfer and low intensity of knowledge translation during the knowledge sharing dynamic between buyer and supplier.*

4.4 Summary of the case study propositions and resulting framework

Based on the aforementioned results from our multiple case study observations and propositions, we resume our findings in Figure 6. This figure shows six different KS dynamics in the buyer-supplier integration for servitization-driven BMI, which is the

summary of the propositions presented in our results. The framework also shows all the possible combinations for the BMI approaches for servitization and the possible forms of relationship between buyer and supplier. We also highlight the different intensity observed on each level and case by means of different colors in the KS levels.

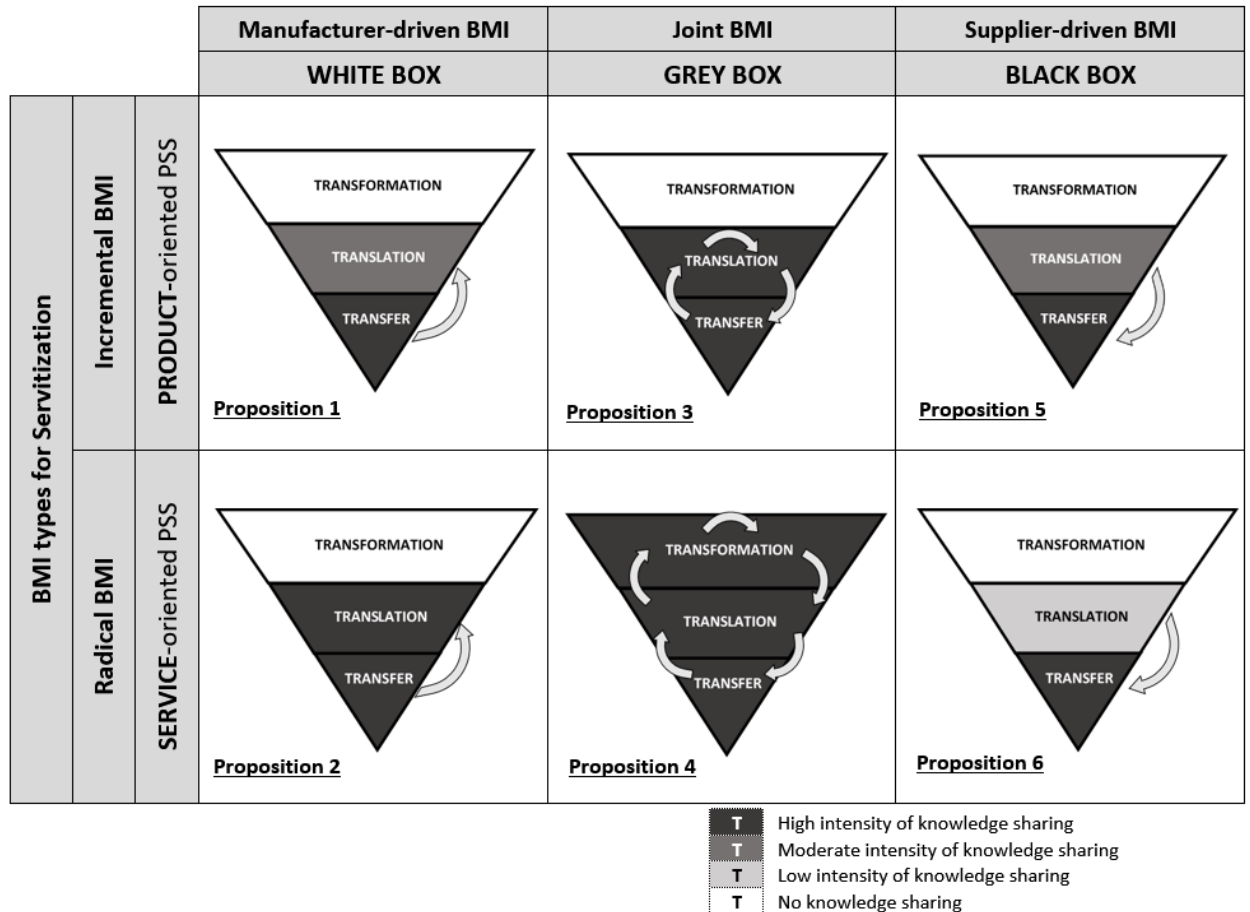


Figure 6 – Overall framework for the knowledge sharing dynamic in the buyer-supplier integration servitization

The results presented in Figure 6 can also be compared across the different types of configurations: for each BMI orientation, this means comparing the differences emerging when the type of relationship with service suppliers changes. For instance, focusing on product-oriented PSS and analyzing both extremes (White and Black boxes), it is possible to observe the same knowledge intensities, but a different direction of the interactions between KS levels. Following such logic, we observe that in the White Box, most of the knowledge is generated and remains in the manufacturing company during all phases of the PSS development. The service company is involved only in the service execution phase. Therefore, the generated documents are shared jointly with products specifications preceding

a broader discussion to avoid misunderstanding about the execution of the service. On the other hand, in the Black Box, the manufacturing company first has to share with the service company information on how the product works, how it is used by their clients, the main characteristics of the users, and other details which are difficult to explain in an explicit manner to a service company. Contrary to White Box, in this case most of this KS happens in the first stages of the development of the PSS offering. When analyzing the service-oriented PSS, we can observe the same behavior; however, some difference exists in the intensity of knowledge translation. Lastly, when comparing the Grey Box configuration with the other configurations for both types of BM orientation, the main difference observed is the cyclical movement between each type of knowledge. In White and Black boxes the process of development of the PSS was in charge of one of the actors, while in Grey Box there is not a main actor, since both actors are building up the solution jointly. Therefore, KS happens in an iterative form.

Additionally, from a BMI theoretical perspective, our resulting framework shows that an incremental BMI occurs when companies follow a product-oriented strategy, while a radical BMI takes place when companies follow a service-oriented PSS strategy for servitization. Considering manufacturing companies in the first group, services have less impact in the innovated business, since their value proposition (the BM's key element of "what" is offered to create value) remains focused on the products; as a result, BMI reflects on changes that are deemed incremental. On the other hand, manufacturing companies from the second group (i.e. radical BMI) are those willing to transform their product to better fit the value proposition with the service offering, implying a radical change in the "what", which later propagates to the other BM elements (MITCHELL; COLES, 2004); this determines a significant modification of the manufacturers' value architecture (TEECE, 2010; MASSA et al., 2017). Moreover, our framework illustrates how both incremental and radical BMI levels may appear in each supplier involvement type (White, Grey and Black Box). When the collaboration approach follows a White Box configuration, BMI is driven by the manufacturer, who will centralize the decisions of service design, reducing the dependence of BMI from external actors; such leading role in BMI will require the manufacturing company to internally develop service design resources and capabilities, that may be later used to simply add a service component to the product – as depicted in Proposition 1 – or even leveraged to implement a new service that radically changes how the product is offered – as Proposition 2 illustrates. This finding shows how service design may become not only a

product component, but even a core resource (BARNEY, 2001) to enable a profound BMI from manufacturing companies towards servitization. On the other hand, when collaboration is based on a Black Box configuration, BMI is supplier-driven. The PSS solution (value proposition) and the resources and activities needed will depend on the service innovation proposed by the supplier. In this case, the service supplier, by leveraging its core resources, assets and know how, will provide novelty to the manufacturer's BM; such novelty will be embedded to different degrees, depending on the manufacturer's willingness to allow its service partner to incrementally (Proposition 5) or radically (Proposition 6) modify also the product configuration the services are attached to. Grey box is a half-way positioning where the joint solution implies also a BMI that is equally driven by the manufacturing and the service firms. In this case, the manufacturer and the supplier will modify internal business dimensions and will influence each other during such change; there is a mutual dependency in aspects like the resources configuration, processes and design activities, and the resulting BMI may show a focus on product (Proposition 3) or service (Proposition 4).

Moreover, based on the case studies, we observed that the more radical the BMI is, the more impact the service supplier will have on the manufacturer's business dimensions in Grey and Black Box configurations.

5 Discussion

The findings of this study shed light on how a combined buyer-supplier KS and BMI perspectives can be valuable to investigate another wider theme in Operations Management, i.e. the servitization of manufacturing companies. Many prior works treated KS as a "item" or a "package" that can and must be exchanged between collaborators in the context of BMI and servitization (e.g. MEIER; ROY; SELIGER, 2010; STORBACKA et al., 2013), but this is only the starting point for a broader analysis of the complexity involving collaborations for BMI. As we have shown in our findings, such an understanding about these relationships and the KS dynamic can be expanded by bridging two different streams of research: (i) the BMI stream, and within this stream, the research focused on a specific BMI process called servitization strategy; and (ii) the new product development (NPD) stream concerned with buyer-supplier integration/collaboration. We showed that by integrating both perspectives it is possible to obtain a more fine-grained description about the levels of KS among the involved actors. If such relationship is only seen from the BMI point of view (and not from the type of collaboration perspective), prior works emphasized different ways of sharing knowledge for

product or service-oriented models (JAAKKOLA; HAKANEN, 2013; LERTSAKTHANAKUN; THAWESAENGSKULTHAI; PONGPANICH, 2012). On the other hand, when the relationship among actors is considered only from the buyer-supplier integration point of view, the White/Grey/Black Boxes approach allows identifying three main KS dynamics (LE DAIN; MERMINOD, 2014). However, when both perspectives are combined, we showed that six possible dynamics emerge from this phenomenon. These dynamics result from the possible combinations of knowledge among actors, since the type of domain-specific knowledge from each actor directly affects the effort required to cross the boundary knowledge (CARLILE, 2004).

Our findings present some differences compared to the buyer-supplier relationship seen from the NPD lenses only, confirming Johnson and Mena's (2008) affirmation that a servitized supply chain has a different behavior than those involving only products. One general aspect is that, in the NPD buyer-supplier, White Box cases seem to happen more naturally than Grey or Black Box ones (HUANG; CHEN; STEWART, 2010). In NPD, companies generally start working in collaboration by sending the designed components to be manufactured or adapted by the suppliers. In this case, White Box initiatives are more difficult because the company has, at least, part of the competence that the supplier can offer, even when it is not as advanced as the supplier's (AMALDOSS et al., 2000). Therefore, the company first tries to develop its own product components, leaving for suppliers only the less relevant ones (ZIRPOLI; BECKER, 2011). However, thanks to the multiple case study we observed a different trend for servitization-driven BMI. Here, the manufacturing company needs to outsource a service competence, which is generally unknown to the company itself. Thus, Black Box or Grey Box are more likely to happen than White Box, since for White Box the company should first develop a new capability to be able to design the service offering (BAXTER et al., 2009; BRAX, 2005); hence, the uncertainty and high risk forces the company to look for a stronger help in other business units or companies. White Box, in BMI for servitization, seems to be more likely to happen when this BMI is simpler, i.e. when the service is not complex or it refers to a very clear problem for the company.

This analysis does not mean that one type of configuration is better than the other, since this depends on the strategic decisions that the company makes (GEBAUER; FLEISCH; FRIEDLI, 2005; MATHIEU, 2001a). Black Box appears as a more immediate alternative for companies that need to servitize their BM, since they are outsourcing all the service design and development process, while dropping the chance to internally develop service design-

oriented resources. On the other hand, Grey Box configuration can allow the most flexible and, therefore, complete solution, since in this alternative the product can be jointly modified and both product and service-oriented resources and capabilities from buyer and supplier are merged and recombined, possibly generating a more radical BMI. Finally, White Box seems to be an alternative for large manufacturing companies that have the possibility to nurture service-related resources and companies, for instance by hiring people with the necessary abilities to self-design services, but only as long as the market may tolerate a longer time-to-market due to internal development.

Regarding the KS levels, our findings show that in the White Box configuration knowledge translation seems to be more important for BMI aiming servitization than in NPD. This is because a service design is more ambiguous than tangible goods, demanding more discussion to avoid misunderstanding (AURICH; FUCHS; WAGENKNECHT, 2006; KAPLETIA; PROBERT, 2010). However, in this White Box the KS dynamic presents a similar pattern to NPD, where first the manufacturing company provides the product and service specifications (knowledge transfer) and then, on top of it, knowledge translation occurs. Something similar happens in Black Box KS dynamic, where in a general sense there is a similar behavior in BMI for servitization when compared with NPD collaboration according to Le Dain and Merminod's (2014) results. However, for service-oriented PSS, we found that knowledge translation is present, but with a lower intensity when compared with NPD behavior. This is because in our case the value-added offer is centered on the service delivered with the product, which is developed fully by the service supplier. Thus, low levels of translation are needed, only to adjust the PSS offering to be offered.

Still, for the Grey Box configuration, while Le Dain and Merminod (2014) observed that the NPD process requires high levels of all the three types of knowledge and a cyclical dynamic between them emerges, this behavior is not the rule in both types of BMI for servitization. The service-oriented PSS has a similar KS dynamic, since radical new solutions need deep modification of both service and product. However, the product-oriented PSS has a particular behavior in Grey Box, not observed in NPD Grey Box, since we did not identify knowledge transformation. As defined by Carlile (2004), transforming knowledge involves altering current knowledge and creating new knowledge, but this cannot fully happen in this case because of the constraints/limitations to the PSS offering set by the existing product portfolio. Then, KS dynamic is still cyclical, but it concentrates between the phases of knowledge transfer and translation, forcing actors to solve client's problems only with a

different combination of the same products, without being able to create totally new solutions and, therefore, not demanding a true knowledge transformation.

As a concluding remark, our analysis from the BMI and KS perspective contributed to previous studies that found difficulties in knowledge management in the buyer-supplier relationship in a servitization context. For instance, Cook et al. (2006) observed that manufacturing companies were worried about service delivery based on service suppliers because it would reduce their capacity to develop efficient solutions. However, when analyzing by a KS perspective, we show that the Grey Box configuration allows both actors to benefit from the generation of new knowledge. Also, Bastl et al. (2012) and Lockett et al. (2011) found in their case studies that the intensity of knowledge exchange was less than they expected, but our work explains this behavior, since we show that the intensity of KS cannot be generalized for all buyer-supplier relationships. This will depend, according to our results, on which of the six types of buyer-supplier configuration and on which of the two different BMI approaches the collaboration is based on. Finally, our study complements Sacconi's et al. (2014) conclusions that information exchange between buyer and supplier happens differently, conditioned upon the service type offered in the PSS, since we clarified how the different KS levels are managed for different servitization BM orientation and supplier's involvement configuration.

6 Conclusions

6.1 Theoretical contributions

The research question this study addressed was how manufacturing companies willing to innovate their traditional business model to become servitized integrate knowledge from service suppliers to obtain a joint product-service solution. Strategically, we argued that this is a significant challenge for such companies, since they have to deal with a new competence (based on service knowledge) which is, generally, not part of their knowledge domain; also, they need to innovate their BM to turn it into a servitization BM. Therefore, they need to seek external knowledge based on collaboration with service suppliers. Thus, we show the connection between buyer-supplier collaboration and BMI to understand the impact of such relation on the servitization strategy of the company.

The main theoretical contribution of this study, organized in terms of six propositions, is that we explored the connection between two different fields of research – BMI and buyer-supplier integration in NPD – to provide a comprehensive theoretical

framework about possible types of collaboration and levels of KS that can occur in such collaboration aiming for a servitization strategy of the company. Moreover, our study disclosed a relationship between BMI and servitization implementation that is not yet explicit. Our findings showed that viewing the buyer-supplier typologies through the lenses of BMI research (which focuses on the modifications in a company's value architecture – Teece, 2010) can allow gaining a deeper understanding of this research problem. Our study also shows how a manufacturing company's BMI makes the set of interrelated choices explicit within the overall servitized strategy – including the role of collaboration and KS.

Moreover, we also showed different behaviors between the traditional NPD buyer-supplier collaboration and this collaboration in BMI for servitization. We found that KS dynamic depends not only on the type of collaboration, but also on the type of servitization orientation, that is, on whether the BMI is product or service-oriented. Thus, we obtained six forms of KS dynamics for servitization instead of only three as discussed in the extant NPD buyer-supplier literature. Our findings also suggest that only one of the six configurations involve a high intensity of knowledge transformation (i.e. Grey Box for service-oriented PSS), while all other combinations are restricted to the knowledge transfer and translation levels.

6.2 Managerial implications

As implication for managers and practitioners, our findings suggest that before executives choose one type of collaboration with potential service suppliers, they have to be careful concerning two main aspects. First, they need to evaluate not only the type of collaboration they want to establish, but also the strategic characteristic of the proposed solution's BM, whether it will be product or service-oriented, since this will affect directly the dynamic of the collaboration. Secondly, as a consequence of this first point, they should consider the complexity of the KS dynamic they will have to deal with when choosing one of such combinations. As we showed in our results, Black Box configurations may be more appropriate if managers intend to innovate their BM faster for servitization, since it requires lower levels of KS dynamic with suppliers and the company does not need to develop its own service capabilities. However, trusting suppliers and identifying the right service suppliers can be a barrier for this option. Additionally, the value proposition of the manufacturer's BM becomes more dependent from the service suppliers. On the other hand, we also showed that, if managers want to develop stronger PSS solutions, they may opt for a Grey Box

collaboration, but this may require higher intensity of KS with suppliers, especially when the solution is service-oriented, which results in longer times for definition and execution; however, the BMI obtained can be more consistent and performing. Finally, we showed that the White Box option implies to possess internal service capabilities, since the company itself has to develop the service design. Thus, in this case, the KS dynamic with service suppliers is less complex, since they become merely service executers, but the challenge is more on how to internally develop the service competence.

6.3 Limitations and future research

Regarding the limitations of this research, one is that we addressed the proposed research question with a qualitative approach, which may hide observer's biases (Yin, 2009). This is necessary for a first stage of understanding, since we aimed to analyze in depth the KS mechanisms between companies and their suppliers during BMI for servitization. However, future research can employ a quantitative approach, for instance based on a survey research, to obtain statistical validation for our propositions. Another research limitation is related to the fact that we analyzed some cases with internal BUs collaboration and others with external companies' collaboration. In this sense, we assumed that the fact of considering different BUs from the same company would not affect our analysis, as long as they are stand-alone BUs enjoying a strong degree of delegation and autonomy. Future analysis could complement and expand this first study on KS in BMI for servitization and, when possible, quantitative studies could also test whether internal stand-alone BU against external independent companies can present different performance regarding buyer-supplier integration for BMI aiming servitization.

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ARTIGO 2 – Managing servitization in product companies: the moderating role of service supplier involvement*

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Abstract

Purpose – The purpose of this paper is to study service innovation in product companies (servitization) by considering the relationship (moderation) between product companies and service suppliers working in a service triad.

Methodology – We propose that there are three main business dimensions that product companies have to manage in servitization and that the involvement of service suppliers can moderate the effects of these dimensions on the benefits obtained from the Product-Service System (PSS) delivered. To test these hypotheses, we perform a cross-sectional quantitative survey in 104 Brazilian and Italian product companies.

Findings – Our findings show that the three business dimensions are important for servitization while there is a trade-off decision regarding service suppliers' involvement since suppliers act differently depending on the PSS orientation (product or service-oriented).

Research limitations/implications – Our work is limited to the analysis of what should change in a company during servitization and the impact of supplier's involvement. Further research is needed to complement this study by analyzing the process and context of the organizational change.

Originality/value – This is one of the first quantitative studies to provide evidence of how service supplier' involvement affects different servitization business dimensions and the obtained benefits for both product and service-oriented outputs.

Practical implications – Our research contributes an understanding about how the benefits practitioners can obtain from servitization are strongly influenced by the involvement

of service suppliers and how this influence depends on the PSS orientation of the product company.

Keywords Service supply chain; Servitization; Product-service system; Supplier involvement.

Paper type Research paper

1 Introduction

Servitization is a current strategic trend in product companies (BAINES et al., 2017; KOWALKOWSKI; GEBAUER; OLIVA, 2017). It comprises a business transformation from the traditional ‘pure’ product-centered offering to an integrated product and service value offering, often named as Product Service System (PSS) (BAINES et al., 2009b; NEELY, 2009). This integrated approach means that product companies are increasingly dealing with product-related services, such as logistics and distribution, installation and commissioning, maintenance and product-upgrades, personal support and training, and digital services, among others (RAJA et al., 2013; WYNSTRA; SPRING; SCHOENHERR, 2015).

Adopting the servitization strategic approach entails several challenges for product companies (ALGHISI; SACCANI, 2015). One first challenge is to acquire or to develop the tangible and intangible resources required for delivering innovative services which are integrated into companies’ product development (LERTSAKTHANAKUN; THAWESAENGSKULTHAI; PONGPANICH, 2012; MEIER; ROY; SELIGER, 2010; PAIOLA et al., 2013). Naturally, product companies may lack knowledge and competences about service innovation. New product development has been conceived in the traditional product business models as a technology-based set of capabilities (LEONARD-BARTON, 1992; MARSH; STOCK, 2006). Furthermore, product companies frequently dismiss or neglect service-related capabilities as something specific for the after-sales sector (SZWEJCZEWSKI; GOFFIN; ANAGNOSTOPOULOS, 2015).

Observed from a Resource Base View (RBV) perspective (BARNEY, 1991; WERNERFELT, 1984), one possible strategy for product companies is to develop internally their own service capabilities that could be a valuable source of competitive advantage (CAVALIERI; PEZZOTTA, 2012; GEBAUER et al., 2012). However, this can be costly and risky for the business and the outcomes might appear only after a long period of implementation (ERKOYUNCU; DURUGBO; ROY, 2013; SUAREZ; CUSUMANO;

KAHL, 2013). As a second possible strategy, companies might consider the integration of external suppliers as a source of the resources needed to support the servitization transformation (DAVIES, 2004; KRUCKEN; MERONI, 2006; WYNSTRA; SPRING; SCHOENHERR, 2015).

In general, two kinds of suppliers can be relevant in a servitization partnership of a product company: (i) suppliers having a specific service knowledge which is useful for the company; and (ii) external service companies, i.e. companies having their own business focus on a service offering (FINNE; HOLMSTRÖM, 2013; KINDSTRÖM et al., 2015). For this study's purpose we refer to both as service suppliers. Therefore, we consider as service suppliers several kinds of companies that can contribute to the PSS value-offering for product companies. Some examples and cases of these types of service suppliers can be found in the studies of Ayala et al. (2017), Karatzas et al. (2016), Saccani et al. (2014) and Finne and Holmström (2013). By considering the product company and service supplier involvement and its implication for the customers, some studies named this involvement as 'service triad' (WYNSTRA; SPRING; SCHOENHERR, 2015). The service triad has become a prominent topic within the operations management and supply chain management fields (KARATZAS; JOHNSON; BASTL, 2016; WUYTS; RINDFLEISCH; CITRIN, 2015; WYNSTRA; SPRING; SCHOENHERR, 2015). However, the contribution of service suppliers that specifically focus on servitization is scarcely addressed in the literature (BASTL et al., 2012; KARATZAS; JOHNSON; BASTL, 2017). This gap needs to be filled because such suppliers can be potentially promising partners in terms of the complementary knowledge and capabilities they can provide for product companies (COHEN; AGRAWAL; AGRAWAL, 2006; DAVIES, 2004; JOHNSON; MENA, 2008; LOCKETT et al., 2011; MATHIEU, 2001a; WINDAHL; LAKEMOND, 2006)).

Current literature shallowly answers questions such as how product companies can involve their service suppliers into servitization and what the resulting outcome of such involvement is (FINNE; HOLMSTRÖM, 2013; FLEURY; FLEURY, 2014; SACCANI; VISINTIN; RAPACCINI, 2014). Moreover, the few studies in this field are mostly based on theoretical proposition or qualitative research (e.g. BASTL et al., 2012; KARATZAS; JOHNSON; BASTL, 2016; SACCANI; VISINTIN; RAPACCINI, 2014). Theoretical validation based on quantitative research is still limited on this topic (BUSTINZA; PARRY; VENDRELL-HERRERO, 2013; KOWALKOWSKI; GEBAUER; OLIVA, 2017). Given this ongoing discussion in the literature and the lack of studies regarding the service suppliers'

involvement for servitization, we formulate the following research question: *Is the service suppliers' involvement a good strategic choice for product companies pursuing a servitization approach?* Based on this research question, we aim at investigating whether product companies should (i) dedicate their efforts to establish partnerships with service suppliers in order to offer product-service solutions or (ii) try to develop their own business conditions to offer such solutions independently from external partners.

To answer the research question, first, we identified in the literature three business dimensions that are relevant for the servitization implementation from a Resource-Based View (RBV) of the firm perspective. Then, we investigated the moderating role of service supplier involvement in the relationship between the different business dimensions and the benefits obtained. Since the expected benefits for a product company can differ according to its PSS orientation (MATHIEU, 2001b), we consider two groups of benefits, i.e. product-oriented and service-oriented. We study the relationship between different business system dimensions by means of a quantitative survey with 104 Brazilian and Italian product companies which are engaged in servitization. Our results show different (and some unexpected) effects of the service suppliers' involvement in servitization. Moreover, responding to Luoto's et al. (2017) and Kowalkowski's et al. (2017) call for more servitization studies in developing countries, one subset of our sample considers results from the emerging economy Brazil, where product innovation is facing different challenges in comparison to more developed countries (FRANK et al., 2016). In a second step, we compare the findings for Brazil with the results for the second subset of product companies from the North of Italy, which is a developed region.

The remaining sections are organized as follows. First, we present the theoretical background that provides the arguments for developing the research hypotheses. Second, we explore how prior literature expresses the importance of the proposed three dimensions (service offering, resource base, and activity system) to achieve servitization benefits, as well as how supplier involvement can influence the relationship between these three dimensions. Based on this exploration we propose corresponding hypotheses. Third, we introduce methodological aspects of this research which consist of a survey application and subsequent statistical analysis. Fourth, we describe the findings of our study. The fifth section discusses these results and finally, in the sixth section we present final remarks and conclusions of this work.

2 Theoretical Background and Research Hypotheses

Different theoretical perspectives have been used to analyze inter-organizational relationships in a pure product context (MENA; HUMPHRIES; CHOI, 2013; PALMATIER; DANT; GREWAL, 2007) and in a PSS context (KARATZAS; JOHNSON; BASTL, 2016; WYNSTRA; SPRING; SCHOENHERR, 2015), such as resource base view of the firm, transaction cost economics, social exchange theory, among others. Particularly for this study, we adopt a Resource-Based View (RBV) theoretical lens (BARNEY, 1991; WERNERFELT, 1984). As affirmed by Wernerfelt (1984), a resource (tangible or intangible) is anything that could be thought as a strength or weakness for a company. According to the RBV theory, companies from an industry sector are normally heterogeneous, controlling different strategical resources that are not transferable across firms and that serves as a source of sustained competitive advantages (BARNEY, 1991).

From a RBV perspective, companies join a network to collaborate with other firms, which allows access to new resources to extend and complement their internal needs to improve the overall performance and competitiveness (BARNEY, 2012; MENA; HUMPHRIES; CHOI, 2013). This behavior is particularly highly observed in the servitization context, where product companies normally find difficulties to develop internally the different resources needed to offer product-service solutions (BASTL et al., 2012; FINNE; HOLMSTRÖM, 2013). As expressed by Wynstra et al., (2015), in service triads, the product company can take advantage of specialized capabilities of service providers, being possible to perform services with higher standards, while maintaining the focus on its core competences. The main objective of the combination of resources between product company and service provider is to reach together the benefits resulting from offering PSS, as described in the following sections.

2.1 PSS benefits and orientations

There are several suggestions in the literature claiming that servitization can bring a wide range of benefits for product companies (e.g. BAINES et al., 2007; CHESBROUGH, 2011; LINDAHL; SUNDIN; SAKAO, 2014). Nevertheless, the benefits that can be expected by companies depend on their respective servitization strategy and the orientation of the company's PSS (KAPLETIA; PROBERT, 2010; MATTHYSSENS; VANDENBEMPT, 2010). Among the existing perspectives on PSS (e.g. GAIARDELLI et al., 2014; MANZINI;

VEZZOLI, 2003), we have followed the proposition of authors such as Galbraith (2002), Kapletia and Probert (2010) and Matthyssens and Vandenbempt (2010) who consider that the PSS orientation in a company can be subdivided into two main foci: a product-oriented PSS and a service-oriented PSS. In the first case, companies are more focused on finding as many uses and customers as possible for their products (GALBRAITH, 2002). In this first focus, companies are using the services to extend products, i.e. to support their utilization (CUSUMANO; KAHL; SUAREZ, 2015; KOWALKOWSKI et al., 2017). Some examples of services in a product-oriented PSS are maintenance, delivery of spare parts or product-upgrade. In the second focus (service-oriented PSS), companies are more customer-centered and the offered solutions may be not be restricted by the product itself (GALBRAITH, 2002). Companies use these offered services mainly to support customers' activities (KOWALKOWSKI; GEBAUER; OLIVA, 2017), and this approach usually leads to a highly customized solution that requires a significant level of customer involvement including potential changes in product design or the way products are offered (CUSUMANO; KAHL; SUAREZ, 2015; GAIARDELLI et al., 2014). Some examples for such services are an automation company offering process optimization solutions instead of just robots, or an energy company offering a complete solution (from project to operation) for power supply for a customer's new product plant.

Since the PSS orientation can differ among companies, the expected benefits from these two orientations may also change. Companies with a product-oriented PSS deliver services to leverage the sales of products to their existing customers, and even to use the knowledge collected from service delivery to develop new products (KOWALKOWSKI et al., 2017; MATHIEU, 2001a). Furthermore, these companies use services as a means of reaching new customers and markets with their existing products (GEBAUER; GUSTAFSSON; WITELL, 2011; RADDATS et al., 2016). Companies with a service-oriented PSS have the main objective of retaining customers by creating loyalty and delivering novelty (SANTAMARÍA; JESÚS NIETO; MILES, 2012; VANDERMERWE; RADA, 1988), while adapting to their customers' needs and requirement for more added value (MATTHYSSENS; VANDENBEMPT, 2010; RADDATS et al., 2016). There are other benefits from servitization that we will not address in this paper because they are equal for both orientations, such as higher profit margins, stable income and revenues, and higher competitiveness (GEBAUER; GUSTAFSSON; WITELL, 2011; MATHIEU, 2001a).

2.2 Structuring the business dimensions for servitization

Independently from their PSS orientation, product companies heading towards servitization must face an internal business transformation in order to develop the resources needed to achieve the potential benefits (BAINES; SHI, 2015; MARTINEZ et al., 2016). Prior research addresses different structural changes that are necessary in the strategy and operation of companies which are aiming for servitization (GAIARDELLI et al., 2014; RABETINO; KOHTAMÄKI; GEBAUER, 2015). Bigdeli et al. (2017) adapt some propositions from strategic change literature to the specific context of servitization implementation. They suggest that a company needs to consider three main aspects for such a transformation: the *content* of a chosen strategy, i.e. **what** changes; the *process* of change which reveals various content alternatives, i.e. **how** it changes; and the *context* in which the company's change occurs, i.e. **why** it changes. In this paper, following a RBV perspective, we focus our attention specifically on the content of the change, i.e. what resources change related to servitization in product companies.

The literature proposes different dimensions to address what should be changed or adapted in the business content of product companies in relation to servitization implementation. In a general sense, authors address three main dimensions (BÖHM; EGGERT; THIESBRUMMEL, 2017; GEBAUER et al., 2012; SANTAMARÍA; JESÚS NIETO; MILES, 2012; WIT; MEYER, 2010): (i) *which focus* should the product company adopt, which in our context is the strategic focus on the development of the resources needed for servitization; (ii) *what conditions are required*, i.e. the internal conditions regarding intellectual resources such as knowledge, skills and capabilities; and (iii) *which activities should be performed*, considering activities and organizational arrangements and resources to operationalize the adopted strategy. In the next subsections, we discuss these dimensions and propose our hypotheses regarding their impact on the benefits of each PSS orientation. We adopt a terminology which is inspired by propositions of Wit and Meyer (2010), since they use the broadest terminology in terms of content compared to other authors and since this terminology is well known in the strategic management literature (BIGDELI et al., 2017). Thus, following Wit and Meyer (2010), we name the business system dimension that considers 'what focus' as the '*service offering*' conditions. '*Resource base*' is the term for the dimension that considers 'what conditions' and '*activities system*' is the name for the dimension that considers 'which activities' should be implemented. Next, we detail each of these three business dimensions.

2.2.1 Service Offering dimension for servitization

Based on prior studies, we define the ‘*service offering*’ dimension of servitization in a business system as the service-based conditions by which a product company offers value to its customers, i.e. the intangible resources a product company should develop in order to offer a PSS (BÖHM; EGGERT; THIESBRUMMEL, 2017; GEBAUER et al., 2012; SANTAMARÍA; JESÚS NIETO; MILES, 2012; WIT; MEYER, 2010). The servitization literature clearly stresses the importance of this strategic aspect in the organizational transformation of a product company aiming to benefit from servitization. The competitive advantage due to servitization is based on the company’s understanding of how the additional service value is perceived by customers and on the ability to offer sustainable solutions to meet their expectations (GAIARDELLI et al., 2014). This competitive advantage transforms services into direct enhancers of the tangible products’ value (DAVIES, 2004; MATHIEU, 2001a; WINDAHL; LAKEMON, 2010). The delivery of additional value concerning the offering leads to more satisfied customers (LOCKETT et al., 2011). Hence, some product companies see servitization as a strategy for improving their customer relationship by enhancing information sharing and by focusing on their overall interaction with customers, allowing the companies to rapidly respond to their customers’ needs (BAINES et al., 2017; CUSUMANO; KAHL; SUAREZ, 2015). This strategy provides companies a possibility for differentiation within a competitive market (PENTTINEN; PALMER, 2007). As Bastl et al. (2012) and Kohtamaki et al. (2015) demonstrate, an inherent characteristic of servitization is the increased level of customer orientation. Product companies shift from a focus on the proper functioning of their product(s) to a focus on efficient and effective use of their solution offering(s) by the customer. Moreover, this customer focus increases companies’ benefits, since it allows them to better understand and offer a superior value that can ‘lock-on’ customers. This potential benefit implies that customers freely choose loyalty towards the company (VANDERMERWE, 2000). By applying this customer-oriented perspective from the literature, we can state that the development of the service offering dimension of servitization is essential for the success of a PSS, regardless the company’s orientation. Thus, we propose Hypothesis 1:

H1: The existence of a service offering business dimension for servitization is associated with higher benefits obtained from both a Product-oriented PSS (H1a) and a Service-oriented PSS (H1b).

2.2.2 Resource base dimension for servitization

The second dimension, named ‘resource base’, refers to what should change in aspects related to the human assets, such as individual expertise, competences, knowledge and flexibility, in order to be able to deal with the PSS offering (BÖHM; EGGERT; THIESBRUMMEL, 2017; GEBAUER et al., 2012; SANTAMARÍA; JESÚS NIETO; MILES, 2012; WIT; MEYER, 2010). New strategic orientation towards servitization requires a structural change of the product company (GEBAUER et al., 2010; KREYE; ROEHRICH; LEWIS, 2015). The company needs to reframe its human resources to deal with new dynamic product *and* service market conditions, which demand greater internal flexibility (JOHNSTONE; DAINTY; WILKINSON, 2009; MATTHYSSENS; VANDENBEMPT, 2010; NEU; BROWN, 2005). While a new product offering can be preconfigured and standardized, frequently this is not the case for services that are inherently fuzzy and difficult to define. New service offerings usually demand a development of new corporate competences (BRAX; JONSSON, 2009; SLACK, 2005). Human capital and knowledge become a main source of competitive advantages due to the fact that service offering implies dealing directly with the customer and with problem-solving situations, resulting in a higher solution variability (BAINES et al., 2009b; TULI; KOHLI; BHARADWAJ, 2007). Further, employees that are involved in service activities must be proactive, they need to have more interpersonal flexibility, and they must be more sensitive on average than employees who work with products (BARNETT et al., 2013). Moreover, product companies that are following a servitization strategy may have to deal with significant challenges such as cultural issues due to fundamental changes in the organizational structure or limitations of employees’ knowledge about the offering (MONT, 2002; SLACK, 2005). Thus, when product companies make efforts to enhance their resource base to actively address these challenges, we expect that they obtain more benefits from PSS delivery, regardless of their orientation. Consequently, we propose Hypothesis 2:

H2: The existence of a resource base dimension for servitization is associated with higher benefits obtained from both a Product-oriented PSS (H2a) and a Service-oriented PSS (H2b).

2.2.3 Activity system for servitization

The third dimension of a business system is the ‘*activity system*’, which is defined in the servitization context as the product internal processes of the company to develop a

superior PSS offering (BÖHM; EGGERT; THIESBRUMMEL, 2017; GEBAUER et al., 2012; SANTAMARÍA; JESÚS NIETO; MILES, 2012; WIT; MEYER, 2010). This definition considers operational aspects that are highlighted in PSS literature as crucial for offering a superior experience to customers. Hence, a product company must conduct several activities. First, it needs to integrate the resources and processes of its internal functions (whether from different teams, departments or other units) to enhance the solution effectiveness (TULI; KOHLI; BHARADWAJ, 2007). As demonstrated in Paslauskis et al. (2016), the integration of after-sales support and engineering, as well as the development of knowledge transfer activities among other functional areas involved in the servitization process (e.g. product and marketing), is essential for the success of the PSS solution. Another important aspect of this operationalization is the level of customization of the solution package (DURUGBO; RIEDEL, 2013; MONT, 2002). Frequently, a more customized solution is associated with more satisfied customers, since it requires a stronger proximity to and interaction with them. A customized solution package demands the development of an interface team and of processes to bridge the internal development of the product company with the external requirements of the market (KINDSTRÖM; KOWALKOWSKI, 2009; SLACK, 2005). Due to such requirements, most of the companies start servitization with a standardized solution package (e.g. after-sales services) and move after the beginning of the transformation process towards a more customized solution with additional value for the customer (GEBAUER, 2008; MATTHYSSENS; VANDENBEMPT, 2010). This approach can imply the joint design of products and services by company and customer for the co-creation and delivery of value that levers customer loyalty and attracts new customers (DURUGBO, 2014). Moreover, although servitization solutions may be complex and customized, the internal service processes of product companies need to be well structured for the strategic positioning of service operations (JOHANSSON; OLHAGER, 2004). The realization of a truly integrated PSS requires the coordinated management of service and product development processes towards a beneficial solution for the customer (BRAX; JONSSON, 2009; KINDSTRÖM; KOWALKOWSKI, 2009). Therefore, all these activities are required independently if the company chooses the delivery of a product-oriented PSS or a service-oriented PSS, which leads us to propose Hypothesis 3:

H3: The existence of an activity system dimension for servitization is associated with higher benefits obtained from both a Product-oriented PSS (H3a) and a Service-oriented PSS (H3b).

2.3 The moderating role of Service suppliers' involvement

Although the potential benefits of servitization are high, servitization is not an easy transformation. The overall business risk usually increases when product companies decide to innovate in the field of services (BENEDETTINI; NEELY; SWINK, 2015). A first source of risk is the necessary rearrangement and development of internal resources (BENEDETTINI; NEELY; SWINK, 2015), which is represented in this work by the three business system dimensions aforementioned. Thus, the partnership with service suppliers appears as an alternative for product companies to overcome the barriers and challenges of the servitization journey (ALGHISI; SACCANI, 2015; RADDATS et al., 2017). As expressed by Bastl et al. (2012), this partnership is a source of above normal earnings because it allows access to previously unavailable resources. This strategy implies that the product company enters into a service triad together with the supplier and the customer (WYNSTRA; SPRING; SCHOENHERR, 2015), as shown in Figure 7. The strategic goals of such a service triad can either be to have access to the service supplier's unique resources or to outsource the service part (KARATZAS; JOHNSON; BASTL, 2017; VAN DER VALK; VAN IWAARDEN, 2011). Many researchers highlight the need for product companies to strengthen ties with service suppliers who have the knowledge and skills to offer new solutions (e.g Hakanen and Jaakkola, 2012; Windahl and Lakemond, 2006). Consequently, it is important to study the influence of the customer-supplier integration on the success of servitization in product companies (GEBAUER; PAIOLA; SACCANI, 2013; JOHNSON; MENA, 2008; SACCANI; VISINTIN; RAPACCINI, 2014).

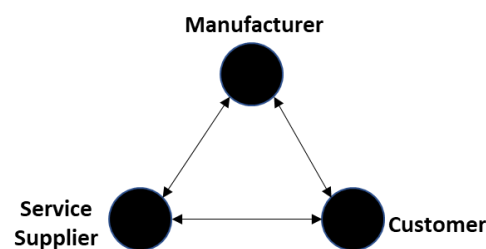


Figure 7: Service Triad (adapted from Wynstra et al. (2015))

Delegating service development for the PSS to partners may allow product companies to offer customers better and more innovative services than what could otherwise be accomplished by internally developing and offering the services (LOCKETT et al., 2011; MATHIEU, 2001a). Paiola et al. (2013) observes that companies focusing on internal

development of the necessary capabilities for offering integrated PSS solutions often lose the opportunity to offer more comprehensive and innovative solutions. Hence, to provide complete solutions to customers, the product company typically has to act as an integrator of the different suppliers that are responsible for the development and sometimes for the delivery of the PSS solution (HAKANEN; JAAKKOLA, 2012; PENTTINEN; PALMER, 2007; STORBACKA, 2011). When collaborating with service suppliers for the delivery of a PSS, companies should decide the intensity of their involvement (AYALA et al., 2016; RADDATS et al., 2017). Consequently, this intensity of involvement with service suppliers will directly affect the way product companies should structure their internal servitization-related business dimensions.

Regarding the service offering dimension, the product company can be restricted by its own limited understanding of the new business opportunities and the possible value proposition for customers (SLACK, 2005). Consequently, external service companies who understand their potential contribution for the PSS offering can help to enhance the product company's vision of the crucial additional value that should be offered (LOCKETT et al., 2011). Hence, the cooperation between product companies and service suppliers can result in a stronger customer orientation of the offered PSS solution (BASTL et al., 2012). Furthermore, with the support of service partners, companies are often better able to complement or increase the functionalities of their own product with the aims of leveraging the sales and reaching new costumers (FINNE; HOLMSTRÖM, 2013; RADDATS et al., 2017). Moreover, servitized product companies can often create more value for their customer and even innovate continuously in the area of their PSS offering by integrating the knowledge which they gather from service suppliers with the internally existing product-related technical knowledge (FINNE; HOLMSTRÖM, 2013; RADDATS et al., 2017). Based on the arguments which we summarized above, we can propose that the influence of suppliers' involvement affects both PSS orientations, which leads us to the following Hypothesis 4.

H4: Service suppliers' involvement moderates positively the association of the service offering dimension on both Product-oriented PSS benefits (H4a) and Service-oriented PSS benefits (H4b).

In addition, supplier involvement may affect the resource base dimension of the business system, since companies pursuing servitization have to make the decision between developing all human resources capabilities internally or delegate it to suppliers and partners. This decision is similar to the 'make or buy' product decision (PAIOLA et al., 2013),

although the internal development of service capabilities can be difficult for product companies because of the overall lack of knowledge background regarding service processes (RADDATS et al., 2017; SLACK, 2005). Furthermore, as Bustinza et al. (2010) discuss, a high degree of service delivery delegation to external partners can be the best option for those activities in which the product company lacks knowledge resources. A closer inter-firm collaboration can help to create a network of partners that fosters the development and delivery of services by outsourcing parts of the solution. During this process the product company's organization can smoothly develop the required new capabilities in its own human assets by absorbing knowledge from the service suppliers (MATTHYSSENS; VANDENBEMPT, 2010; NEU; BROWN, 2008). The collaboration with service suppliers can in this way provide essential skills for the company that would be unavailable without such partnership (RADDATS et al., 2017). Intense contribution of suppliers' knowledge and capabilities may provide greater internal flexibility, since the product company can adapt more easily to the markets' demands by reconfiguring its relationships with those service suppliers that can help to address the required challenges (FINNE; HOLMSTRÖM, 2013; PENTTINEN; PALMER, 2007). Thus, we conclude with the following Hypothesis 5:

H5: Service suppliers' involvement moderates positively the association of the resource base dimension on both Product-oriented PSS benefits (H5a) and Service-oriented PSS benefits (H5b).

Finally, regarding the activity system, the complexity of the processes to develop and deliver product-service solutions can push product companies to partnerships with external service suppliers, since these companies often lack competences on the operational level (LERTSAKTHANAKUN; THAWESAENGSKULTHAI; PONGPANICH, 2012; MEIER; ROY; SELIGER, 2010). Many product companies fail in service operations because they lack operational expertise in this hybrid field (TURUNEN; FINNE, 2014). Particularly, the ability to offer different types of services in the solution, i.e. different levels of customization, can be strongly supported by appropriate service supplier involvement (BASTL et al., 2012; BRAX; VISINTIN, 2016). A product company that opts for working in a service triad can strongly benefit from the integration of its own product development capabilities with the service supplier's expertise (FINNE; HOLMSTRÖM, 2013; JOHNSON; MENA, 2008). Moreover, a service triad allows both partners to be in contact with the customer, leveraging the development of better solutions (FINNE; HOLMSTRÖM, 2013; WYNSTRA; SPRING; SCHOENHERR, 2015). Bastl et al. (2012) stress that when a PSS solution is delivered by a

partnership a closer operational link emerges as consequence of a deliberate inter-organizational effort. Particularly, in a product-oriented PSS, the involvement of service supplier in the activity system dimension can increase the benefits by supporting the introduction of new services related to the products (RADDATS et al., 2017). In a service-oriented PSS the involvement of a service supplier with a high degree of knowledge can enable new business model developments which have superior additional value for the customer such as, e.g., those with performance-based contracts (SELVIARIDIS; NORRMAN, 2014). Therefore and based on the literature, we can formulate the following Hypothesis 6:

H6: Service suppliers' involvement moderates positively the association of the activity system dimension on both Product-oriented PSS benefits (H6a) and Service-oriented PSS benefits (H6b).

The model shown in Figure 8 summarizes the proposed hypotheses as they relate to the three business system dimensions of our study's focus. Our hypotheses envisage that when a company's *service offering*, *resource base* and *activity systems* business dimensions focus on PSS, this focus positively influences the Servitization Benefits (hypotheses H1, H2 as well as H3 respectively) and the involvement of service suppliers positively moderates these effects on servitization benefits (Hypotheses H4, H5 and H6) for both product-oriented and service-oriented PSS.

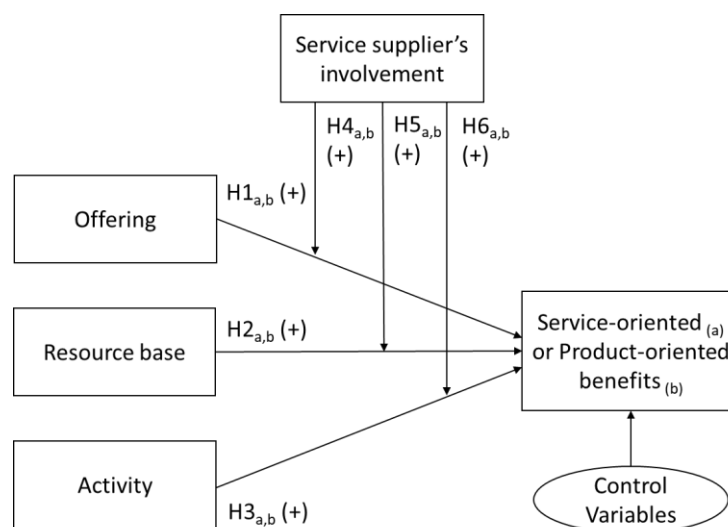


Figure 8: Theoretical model

3 Research Method

3.1 Sampling and measures

To investigate the proposed hypotheses, we performed a cross-sectional survey in Brazilian and Italian product companies that offer service solutions in their portfolios. We obtained our sample from two industrial research networks, one in Brazil and coordinated by two federal universities as well as another one in Italy and coordinated by a public university. By means of this network we have access to executives with engagement in the offering processes of product-service solutions. We submitted the questionnaire to a group of 347 companies from Southern Brazil and to 216 companies from Italy, both engaged in service innovation activities. We obtained a total of 213 answers (148 Brazilian and 65 Italian). However, for the variables used in this work only 104 of the received questionnaires were complete (response rate of 18.47%). Table 5 shows the composition of the sample.

Table 5: Sample composition (n = 104 companies)

Category	Description	Num.	(%)	Category	Description	Num.	(%)
Industrial sector	Manufacturing	40	38%	Company's size	Small (<100 employees)	31	30%
	Construction	9	9%		Medium (100-500 employees)	21	20%
	Metallurgical	8	8%		Large (>500 employees)	52	50%
	Food	15	14%	Country	Italy	43	41%
	Furniture	7	7%		Brazil	61	59%
	Healthcare devices	2	2%	Business Focus	B2B	79	76%
	Hardware (IT)	7	7%		B2C	25	24%
	Others (<3 by industry)	16	15%	Portfolio	More products than services	85	82%
			More services than products		19	18%	

3.2 Variable operationalization and questionnaire

Regarding the three explanatory variables, we represent them in reflective constructs which are composed by multiple-item scales. Since there is little prior research on quantitative aspects regarding servitization, we created new scales based on suggestions and empirical investigations from the PSS literature, as presented in Table 6. The *service offering* [OFFERING] dimension is represented as the composite of five items (Table 6). Additionally, we measure the *resource base* [RESOURCE] dimension by four items and the

operationalization of the *activity system* [ACTIVITY] dimension by six items (see both in Table 6). For the moderator variable of the model, *service supplier involvement* [SERV_SUPP], we use a composite scale (formative) of five items since we consider different types of collaboration that the product company can adopt for service supplier integration (based on PETTERSEN et al., 2005). Thus, to measure the intensity of collaboration between suppliers in the service development process of PSS we consider the cumulative intensity of different possible collaboration activities (Table 6). Finally, we measure the two dependent variables *product-oriented benefits* [P-O_BENEF] and *service-oriented benefits* [S-O_BENEF] as a multiple-item scale that considers the service contribution based on four different items for each construct (Table 6). We measure all items using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). We summarize the variables and references in Table 6 and document the complete questionnaire in Appendix A.

Table 6: Items of the scales

Constructs	Main concept of the question (item)	Main references used for the construct
Service Offering [OFFERING]	Service as a competitive advantage	(BAINES et al., 2009a, 2010; BASTL et al., 2012; BUSTINZA et al., 2015; DAVIES, 2004; DESHPANDE; FARLEY; WEBSTER, 1993; EGGERT et al., 2013; GALBRAITH, 2002; LEONI, 2015; LOCKETT et al., 2011; MARTINEZ et al., 2010; MATHIEU, 2001a; PENTTINEN; PALMER, 2007; WINDAHL; LAKEMOND, 2010)
	Differentiation by services	
	Value added by services	
	Service to meet customers' needs	
	Customer orientation	
Resource Base [RESOURCE]	Internal development of new competences	(BAINES et al., 2009b; BARNETT et al., 2013; BRAX; JONSSON, 2009; GEBAUER et al., 2010; GEBAUER; GUSTAFSSON; WITELL, 2011; HELFAT; PETERAF, 2003; JOHNSTONE; DAINTY; WILKINSON, 2009; KIMITA et al., 2015; KREYE; ROEHRICH; LEWIS, 2015; LEONI, 2015; MATTHYSSENS; VANDENBEMPT, 2010; NEU; BROWN, 2005; SLACK, 2005; TULI; KOHLI; BHARADWAJ, 2007)
	Individual expertise for service offering	
	Internal flexibility	
	Internal knowledge related to services processes	
Activity System [ACTIVITY]	Joint development of products and services	(BAINES et al., 2010; BIKFALVI et al., 2013; DURUGBO, 2014; DURUGBO; RIEDEL, 2013; JOHANSSON; OLHAGER, 2004; KINDSTRÖM; KOWALKOWSKI, 2009; MONT, 2002; PASLAUSKI et al., 2016; RADDATS; KOWALKOWSKI, 2014; SLACK, 2005; SZWEJCZEWSKI; GOFFIN; ANAGNOSTOPOULOS, 2015; TULI; KOHLI; BHARADWAJ, 2007)
	Involvement of service area in the NPD process	
	Involvement of functional areas in solution development	
	Involvement of customers in solution development	
	Involvement of other BU in solution development	
	Solution customization	
Service Suppliers' Involvement [SERV_SUPP]	Complete outsourcing of services	(FINNE; HOLMSTRÖM, 2013; JOHNSON; MENA, 2008; PETERSEN; HANDFIELD; RAGATZ, 2005; SACCANI; VISINTIN; RAPACCINI, 2014)
	Complete internal development of services (inverse scale)	
	Internal design of services and outsourced delivery	
	Complementary competences of partners	
	Active suppliers' participation	
Product-oriented benefits [P-O_BENEF]	Service contribution for new product sales	(GEBAUER; GUSTAFSSON; WITELL, 2011; KOWALKOWSKI et al., 2017; MATHIEU, 2001a; RADDATS et al., 2016)
	Service contribution for new product development	
	Service contribution to access new customers with extant products	
	Service contribution to access new markets with extant products	
Service-oriented benefits [S-O_BENEF]	Service contribution to customer loyalty	(MATTHYSSENS; VANDENBEMPT, 2010; RADDATS et al., 2016; SANTAMARÍA; JESÚS NIETO; MILES, 2012; VANDERMERWE; RADA, 1988)
	Service contribution to adapt products to customers' needs	
	Service contribution to innovation	
	Service contribution to value added to customers	

We also include control variables in our regression models for servitization performance following Paslauski et al. (2016). First, we consider firm size in two dummies for three main levels, following the Brazilian government definition: small (<100 employees),

medium (100 to 500 employees) and large (>500 employees). We use this approach because the implementation of a servitization strategy is a form of business innovation which is reported in the literature as affected by companies' size (BAINES; SHI, 2015; EGGERT et al., 2013; GEBAUER; PAIOLA; EDVARDSSON, 2010). Second, we include the business focus (Business to Business – B2B = 0; or Business to Consumers – B2C = 1) as a control variable. We consider this second variable because the types of service offering and the promptness of such service offerings may vary if the business is focused on other business companies or on final customers (BUSTINZA et al., 2015; TUKKER, 2015). Moreover, since the sample is composed of companies from two countries, one developed and one emergent, we include country as a third control variable (Italy = 0; Brazil = 1). Finally, we also include the percentage of portfolio distribution of product and service offerings to consider whether the company is more oriented towards products or services (BAINES et al., 2009b; GEBAUER; BRAVO-SANCHEZ; FLEISCH, 2008). Because we are only interested in servitized companies, we discarded companies with absolute scales (only product or service offering).

3.3 Sample and method variance

Firstly, we tested potential sample bias using Levene's test for equality of variances and a t-test for the equality of means between early and late respondents for the two samples (Brazil and Italy). These results indicated no differences in means and variation in the two groups and, consequently, no evidences of significant difference with the population (ARMSTRONG; OVERTON, 1977). On the other hand, potential differences between both countries in terms of servitization strategies were included in the regression model as a control variable.

Regarding the common method variance, we use several techniques suggested by Podsakoff et al. (2003) to reduce this risk. First, we randomized the questions' order to avoid that the respondent may directly associate variables that could be expected to have a relationship. In addition, we sent our questionnaire to key respondents, all of whom are executives that are engaged in the strategic and operation planning of PSS offerings. Finally, we calculated the Harman's single-factor test with an exploratory factor analysis to address common method bias (PODSAKOFF et al., 2003). This test with all independent and dependent variables resulted into a first factor that comprehended only 19% of the observed variance. Therefore, since there was no single factor accounting for the majority of the

variance in the model, this test indicates that common method bias was not a problem in the sample. However, as highlighted by Guide and Ketokivi (2015), we cannot conclude the absence of common method variance since the only certain way to avoid this problem is considering non-single respondents for each company. We have thereby taken all possible precautions but there is still an innate limitation of survey studies.

3.4 Measure validity and reliability

For the multi-item reflective constructs (RESOURCE; ACTIVITY; OFFERING, P-O_BENEF and S-O_BENEF) we validate unidimensionality by means of a confirmatory factor analysis (CFA) with STATA 13.0. This test indicates a good fitness of each multi-item construct proposed (OFFERING: CFI = 0.979; RMSEA = 0.067; RESOURCE: CFI = 0.996; RMSEA = 0.036; ACTIVITY: CFI = 0.969; RMSEA = 0.062; P-O_BENEF: CFI = 0.998; RMSEA=0.034; S-O_BENEF: CFI = 0.994; RMSEA=0.048). All items strongly load on their constructs (factor loading p-value < 0.01) in the inputs and outputs models. The construct reliabilities were all higher than 0.7.

We also tested discriminant validity based on Bagozzi et al. (1991) who suggest a series of two-factor model estimations. For each pair of possible constructs we perform two CFA models and compare their respective goodness of fit. In the first model, we restrict the correlation between the two constructs to unit, while in the second model we free this restriction and calculate the goodness of fit for the original constructs. In this test the overall results show discriminant validity ($\Delta\chi^2 > 3.84$, p-value < 0.05; BAGOZZI ET AL., 1991).

The correlation matrix for all main variables and their respective means as well as standard deviations are shown in Table 7. We also demonstrate in this Table the composite reliability and Cronbach's alpha values of the variables.

Table 7: Bivariate correlation matrix with descriptive scales and reliability estimates

	Mean	S.D.	SERV_ SUPP	OFFERING	RESOURCE	ACTIVITY	P-O_ BENEF	S-O_ BENEF
SERV_SUPP (sum)	12.36	3.13	--					
OFFERING	3.43	0.842	0.085	--				
RESOURCE	3.62	0.787	0.017	0.554**	--			
ACTIVITY	3.12	0.771	0.167	0.661**	0.548**	--		
P-O_BENEF	3.45	0.829	-0.069	0.644**	0.486**	0.545**	--	
S-O_BENEF	3.54	0.800	-0.022	0.712**	0.570**	0.641**	0.756**	--
Cronbach's Alpha	N/A		N/A	0.75	0.73	0.75	0.75	0.73
Composite Reliability	N/A		N/A	0.76	0.70	0.75	0.78	0.73

N/A - not available because the construct is measured with a formative scale

3.5 Data analysis

For the data analysis, we use ordinary least square (OLS) regression which was calculated in Stata 13.0®. To test the moderation effects (H4a,b; H5a,b and H6a,b) we standardized the relevant variables and created a multiplicative score for the interaction effect. Therefore, our results report the unstandardized coefficients, since we standardized the scales before the analysis (GOLDSBY et al., 2013). We test to confirm the assumptions of normality, linearity and homoscedasticity for all independent and dependent variables (HAIR et al., 2009). Firstly, we examine the residuals to confirm normality of the error term distribution and, secondly, we evaluate linearity with the plots of partial regression for each variable. Finally, we evaluate homoscedasticity by plotting the standardized residuals against the predicted value and examining the comparison visually. All these tests confirm the required assumptions for OLS regression models.

4 Results

The hierarchical results for the OLS regression models are shown in Table 8 for each dependent variable. Regarding the regression models with product-oriented benefits as dependent variable, the three present significant associations. The first one, which includes only the control variables, shows a significant association ($p < 0.1$) with country. In the second model, we add the direct effects of the independent variables, entailing a significant change in R^2 (change in $R^2 = 0.49$, $p < 0.01$). The third regression model also comprises the moderation effect of service supplier involvement, and displays a significant change in R^2 (change in $R^2 = 0.03$, $p < 0.1$). The final regression model, which contains the direct and moderating variables, is statistically significant (F-value = 9.84, p-value < 0.01) and explains 51% of the variance of

the dependent variable (adjusted $R^2 = 0.51$). Additionally, there is a differentiation of the country as control variable, showing in the complete regression model that the Brazilian sample (control =1) obtains higher benefits ($B=0.336$, $p<0.05$).

Regarding the regression models with service-oriented benefits as dependent variable, the first regression model including only the control variables does not show a significant association. In the second regression model, we add the direct effects of the independent variables, entailing a significant change in R^2 (change in $R^2 = 0.55$, $p < 0.01$). The third regression model also comprises the moderation effect of supplier involvement and displays a significant change in R^2 (change in $R^2 = 0.03$, $p < 0.1$). The final regression model, which contains the direct and moderating variables, is statistically significant (F-value = 13.31, p-value < 0.01) and explains 59% of the variance of the dependent variable (adjusted $R^2 = 0.59$).

Table 8: Hierarchical regression analysis for Product-Oriented and Service-Oriented Benefits^a

	Benefits for product-oriented PSS			Benefits for service-oriented PSS		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Control 1: Country	0.291*	0.395*	0.336**	0.033	0.088	0.121
Control 2: Size_Large	-0.151	-0.111	-0.113	-0.183	-0.133	-0.095
Control 3: Size_Middle	0.016	-0.082	-0.031	-0.184	-0.242	-0.245
Control 4: Business Focus	-0.145	0.162	0.137	-0.294	0.025	0.046
Control 5: Portfolio	-0.309	0.010	0.060	-0.310	0.000	-0.056
OFFERING		0.436***	0.442***		0.367***	0.371***
RESOURCE		0.144*	0.138*		0.163**	0.177***
ACTIVITY		0.109	0.123		0.192**	0.168**
SERV_SUPP		-0.168**	-0.156**		-0.111**	-0.124**
SERV_SUPP X OFFERING			0.177**			-0.135**
SERV_SUPP X RESOURCE			-0.026			0.096
SERV_SUPP X ACTIVITY			-0.130*			0.128*
F-value	1.03	12.15***	9.84***	1.30	16.13***	13.31***
R²	0.05	0.54	0.57	0.06	0.61	0.64
Adj. R²	0.001	0.49	0.51	0.01	0.57	0.59
Change in R²		0.49***	0.03*		0.55***	0.03*

N = 104. ^a Unstandardized regression coefficients are reported. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

As observed in Table 8, the hypotheses H1 and H2 are completely supported in the regression model 2 for both dependent variables, while hypotheses H3 is only partially supported, i.e. only H3b is supported. In other words, the three dimensions of the business system have a significant and direct positive impact on the benefits for service-oriented PSS, but positive effects of only the Service Offering and Resource Base are confirmed for a product-oriented PSS.

When we add the moderating effect of service suppliers' involvement [SERV_SUPP] (Model 3), our results in Table 8 show significant interaction effects in two of the business system dimensions for both dependent variables: Service Offering and Activity System. These results support our hypotheses H4a and H6b. However, for the other two complementary hypotheses (H4b and H6a) the direction of the effect is contrary to those expected. In Figure 9, we present the slopes for each significant interaction with low, moderate and high intensity of suppliers' involvement. Analyzing Figures 3a and 3b, it is possible to observe that for product-oriented benefits the more intensive the service suppliers' involvement, the higher the obtained benefits by the increase in the service offering dimension. The contrary happens when the company looks for service-oriented benefits. In turn, an opposite result is observed when analyzing the activity system dimension (Figures 3c and 3d). In this case, for product-oriented benefits: the more involvement with the service suppliers, the less obtained benefits. However, more service suppliers' involvement is indicated to obtain more service-oriented benefit from the activity system dimension. Finally, we do not find statistical significance for the moderation effect of Service Suppliers' Involvement in the Resource Base dimension as we proposed in both hypotheses H5a and b.

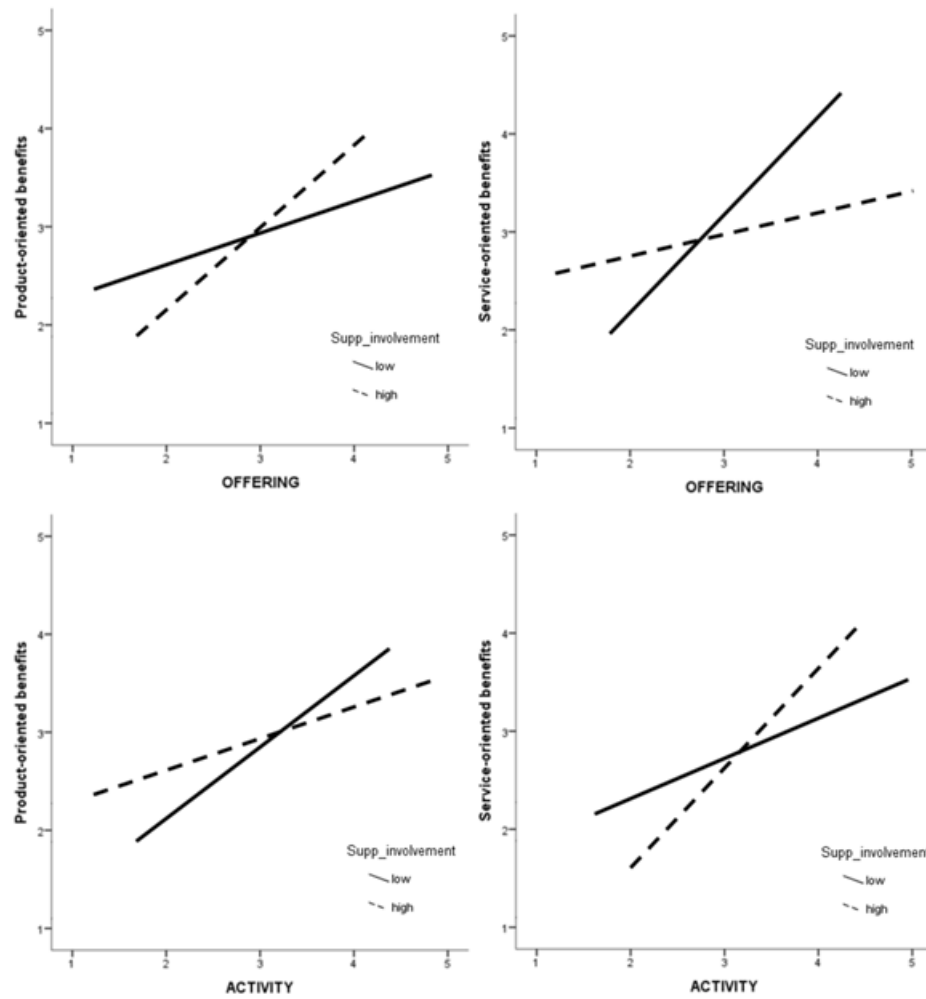


Figure 9: Slopes for the moderating role of supplier involvement on: (A) Offering vs. Product-oriented benefits; (B) Offering vs. Service-oriented benefits; (C) Activity vs. Product-oriented benefits; (D) Activity vs. Service-oriented benefits.

5 Discussion

Our findings shed light on dynamics related to a key aspect of servitization transformation presented by Bigdeli et al. (2017): the content of a chosen strategy. Our results clearly demonstrate what should change in a product company, from a resource base view perspective, in order to obtain more benefits from servitization. In this sense, we confirm what was expressed by means of our hypotheses: the direct and positive impacts of the three business system dimensions on the benefits are relevant for both PSS-benefits orientations. Thus, our results help to clarify the relevance of three different business dimensions that are important for the servitization journey.

Regarding the role of service suppliers in the servitization process of product firms, our findings provide an important contribution for the servitization literature. Contrary to what we expected from our hypotheses based on the extant literature, our findings show that the service suppliers can have different impacts on the business dimensions depending on the PSS orientation benefits. Thus, by adding differentiation of obtained benefits in our model, we show that for product-oriented benefits service suppliers' involvement has positive effects on offering but negative effects for activity, while for service-oriented benefits the contrary happens.

In summary, our findings show that for a product-oriented PSS the increase of the service suppliers' involvement, with its external resources, results in more benefits by the service offering dimension, as hypothesized in this paper. This means that the product company keeps its internal resources focused on the main product-offering strategy and the service suppliers add a complementary service vision to the business (KARATZAS; JOHNSON; BASTL, 2016; RADDATS et al., 2017), which is usually a more comfortable situation for product companies that are at the beginning of the servitization journey (KARATZAS; JOHNSON; BASTL, 2016; VISNJIC; VAN LOOY, 2013). In contrast, in a service-oriented PSS, the moderation role is negative. Our explanation for this unexpected result relates to the concept of the service-oriented PSS, which promotes that the service should become the center of the PSS offering. Our findings suggest that strategic decisions regarding service-centered offerings should rely on the product company and not on the supplier, as also argued by Kowalkowski et al. (2011). When suppliers are involved at this level, the effect of the offering can be reduced in terms of the expected benefit because the company tends to delegate one central aspect of the business for this orientation. In other words, contrary to the product-oriented focus, the service is not a complementary offering but the central one, so the product company should be concerned with internalizing this dimension.

Another comparison can be made for the activity business dimension, where the suppliers' involvement also shows contrary effects for the two PSS orientations. Regarding the product-oriented PSS benefits, our findings show a negative moderating effect of the suppliers which is contrary to our proposed hypothesis. However, Figure 9 illustrates that the contribution of the activity dimension is still positive for the obtaining benefits, even given the negative moderating effect. It is worth noting that this dimension considers mainly the integration of internal processes of product and services areas as well as the customer

involvement in the solution development (BAINES et al., 2010; KINDSTRÖM; KOWALKOWSKI, 2009). Looking at the outsourcing literature on servitization (e.g. LI; CHOI, 2009; WUYTS; RINDFLEISCH; CITRIN, 2015), we can conclude that those product companies who pursue a product-oriented PSS will try to leave most of the operational activities to the service suppliers, resulting in a less relevant internal integration between product and services processes and areas. In addition, the service supplier's involvement is beneficial for service-oriented PSS in this dimension because the product company has the interest of internalizing service processes. In such cases, the service supplier can play the role of a mentor who helps the company to standardize and organize internal services and customer-related processes, i.e. helping to develop the internal resources of the product company (BASTL et al., 2012; FINNE; HOLMSTRÖM, 2013).

The different behaviors for product and service-oriented PSS with involvement of service suppliers are graphically represented in Figure 10. In this figure we align our findings to the service triad from a theoretical perspective (WYNSTRA; SPRING; SCHOENHERR, 2015) by showing the expected force of the ties in a service triad according to the PSS orientation. In the first scenario (Figure 10a), the product company outsources the services to a service supplier because its main focus is still the product (LI; CHOI, 2009; WUYTS; RINDFLEISCH; CITRIN, 2015). Therefore the strongest service tie is between the customer and the supplier who is in charge of the service part. The supplier has also a strong tie with the product company because the first helps the latter to establish the offering strategy, as shown in our results. In the second scenario the product company goes further in the servitization transformation process (VISNJIC; WIENGARTEN; NEELY, 2016) by developing a radical solution where the product is no longer the main focus. In such cases, the service supplier takes a support role during the development of the product company's internal service activities, as shown in our findings. In this case, the strongest ties should be between the product company and the service supplier, because of the need for joint development, as well as between the product company and the customer because the product company delivers the PSS solution to the customer. Particularly, these findings complement the service outsourcing triad's behavior as Li and Choi (2009) formulated it, where the product company first acts as a 'bridge' between supplier and customer and then this initial position decays as the supplier becomes more directly involved with the customer. While this situation normally occurs in a product-oriented PSS, our findings show that the product

companies that pursue a service-oriented PSS should not accept a secondary position in the service triad if they want to reach a more advanced servitization level and its benefits.

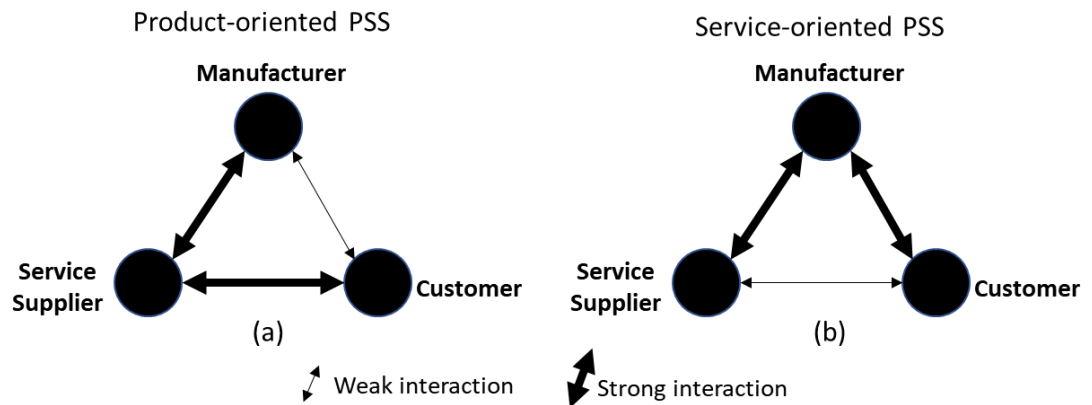


Figure 10: Interaction in a service triad according to PSS orientation

Finally, for the Resource Base system we could not find evidences of a significant moderation effect of the suppliers' involvement on this dimension. This is a surprising result for us, since the servitization literature highlights that one of the main reason to involve service suppliers is to acquire new knowledge and competences for the product company (KOWALKOWSKI; KINDSTRÖM; WITELL, 2011; PAIOLA et al., 2013). One reason for such a counterintuitive result can simply be the lack of discrimination of such an effect in our sample. Another possible explanation can be that most of the companies which are represented in our sample do not see the service suppliers as partners for developing internal resources, but as operational partners to decide the way the PSS will be offered (offering) and for the development of the service process that will be executed (activity). As a consequence of this discussion we can summarize that knowledge sharing in the service triad is something quite difficult to happen since it needs a high level of common understanding between the product company and the supplier- This high level of understanding requires considerable adjustments of both teams' mindsets (AYALA et al., 2016). Therefore, we consider the resource base dimension as the most difficult business dimension in terms of potentials for influence by and benefit from service supplier involvement. Naturally the other two dimensions which are influenced by supplier involvement (offering and activity) might result in indirect internal development of the intellectual resource base of the product company, but we have not tested this possible indirect output in our present work.

6 Conclusion

In this paper, we evaluate the contribution of service supplier involvement for the servitization journey of product companies. As far as we know, this is one of the first quantitative studies to provide evidence of how service supplier' involvement affects different servitization business dimensions and the obtained benefits for both product and service-oriented outputs. Therefore our study helps to consolidate some prior suggestions of qualitative studies and offers new insights for scholars as well as practitioners.

6.1 Contributions to theory and future research

The research contribution of this study is twofold. The first contribution is related to the emergent service triad research field. We demonstrate that the behavior of the dyad company-supplier within a service triad in the context of servitization varies according to the orientation of the PSS strategy which the product company follows. This first finding complements prior research from supply chain management and operational management fields that focused only on product-oriented PSS. A second contribution is our response to the call from servitization literature requesting research which analyzes the link between product companies and suppliers for the delivery of PSS (BAINES et al., 2017). We contribute a more fine-grained understanding of the impact of the involvement of service suppliers in servitization. This additional contribution allows a better understanding of how to involve these partners according to the strategic objectives of the product company.

Our work is limited to the analysis of the 'content' of a chosen strategy viewed from a resource base theoretical perspective, which represents what should change in a company during the servitization journey. Future research should complement this study by analyzing the process and context of the organizational change that occurs related to introducing the supplier as a potential partner when implementing servitization. Furthermore, it is stated in the literature that service suppliers can be involved in different types of collaboration during PSS development and delivery; however, we do not differentiate these types of collaboration in our model. Thus, future studies could study different types of collaboration. Moreover, we do not differentiate various services types, although also this aspect can be correlated to the servitization benefit orientation (product- or service-oriented PSS). Additionally, regarding the sample differentiation between Brazil and Italy, the results show higher product-oriented benefits from Brazilian companies but we have not focused on this aspect. Paslauski et al.

(2017) suggest that service infusion and product extension is greater in an emerging economy due to the companies' lack of control over product development activities (which mainly occur in developed countries) and to its proximity with customers. Thus, context-dependent strategy should be deeply investigated in future studies. The latter point is a further limitation of our study that opens possibilities for future studies to better understand how different types of collaboration with suppliers relate to the different types of services offered.

6.2 Contributions for practitioners

Because product companies have limited knowledge and capabilities about servitizing, very frequently the decision for managers is not whether to start a partnership with service suppliers, but rather how to collaborate with them. Our research contributes an understanding about how the benefits practitioners can obtain from servitization are strongly influenced by the involvement of service suppliers. We demonstrate that managers of product companies should be aware of the importance of selecting partners and assigning roles that clearly align with strategic objectives related to whether the product company's servitization process aims to obtain product- or service-oriented PSS benefits. Managers who want to keep the product as a central activity of the company can use suppliers in supportive roles and involve them in decisions about solution offering strategies; they can also eventually outsource the service execution completely to their partnering suppliers. However, managers who want to pursue a more radical servitization process by focusing on a service-oriented PSS should be concerned with establishing the company's own offering strategy while using the service suppliers as support for the internal development of the corporate service operation. In this case, managers should not use service suppliers for activity outsourcing but instead with the aim of building knowledge from the suppliers in order to eventually accomplish insourcing.

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8 Appendix A - Questionnaire

Questionnaire items to assess Service Offering [OFFERING]: *Concordance*

Likert scale: 1-strongly disagree to 5-strongly agree.

- a) The service offering in my company is considered a strategical aspect for our competitiveness.
- b) We compete primarily in services differentiation.
- c) Our services are offered spontaneously when a customer need is identified.
- d) We understand well how our customer perceives the value of our services.
- e) We are more customer-oriented than our competitors.

Questionnaire items to assess Resource Base [RESOURCE]: *Concordance Likert*

scale: 1-strongly disagree to 5-strongly agree.

- a) To develop our services, we frequently develop new competences inside our company.
- b) The human capital (individual expertise) of my company is a source of competitive advantage.
- c) The internal knowledge owned by my company are considered source of competitive advantage.
- d) Our company is very flexible to deal with market changes.

Questionnaire items to assess Activity System [ACTIVITY]: *Concordance Likert*

scale: 1-strongly disagree to 5-strongly agree.

- a) Our services and products are developed together and simultaneously.
- b) The service area has an active role in taking strategic decisions about new products and markets.
- c) Our different functional areas work often together in the development of new products and solutions.
- d) Our clients have an active participation in the development of our new products and services.
- e) Our solutions are customized, attending to specific demands of our customers.
- f) Other business units of our company are very active in new product and service development.

Questionnaire items to assess Product-oriented benefits [P-O_BENEF]:

Concordance Likert scale: 1-strongly disagree to 5-strongly agree.

- a) Our service solutions facilitate the sales of new products to our current customers.
- b) Our services solutions facilitate the development of new products for the market.
- c) Our services solutions allow us to reach new customers with the extant products of our portfolio.
- d) Our services solutions allow us to reach new markets with the extant products of our portfolio.

Questionnaire items to assess Service-oriented benefits [S-O_BENEF]:

Concordance Likert scale: 1-strongly disagree to 5-strongly agree.

- a) Our service solutions help us to retain customers and to increase their loyalty.
- b) Our service solutions help us to adapt our products to customers' needs.
- c) Our service solutions are often seen as innovative by our customers.
- d) Our services solutions represent a significant value added to our customers.

Questionnaire items to assess Service Suppliers' Involvement [SERV_SUPP]:

Concordance Likert scale: 1-strongly disagree to 5-strongly agree. Formative scale (composite).

- a) The main services offered to our customers are developed and executed predominantly by our own company.
- b) The services offered to our customers are developed and executed predominantly by outsourced companies.
- c) The services offered to our customers are designed in our company, but their execution is outsourced.
- d) To develop our services, we require complementary competences from outside (other partner companies).
- e) Suppliers are active partners in the development of new solutions for our products and services.

Questionnaire items for control variables:

- a) Please, inform the size of your company in number of employees.
- b) Please, describe your main business focus: (B2B; B2C; other).
- c) Please, describe how is composed your company's portfolio (in percentage): (products/services).

ARTIGO 3 – Service triads for servitization: a study of service suppliers' involvement typologies*

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Abstract

Servitization is growing as a new strategic trend of product companies. However, one of the greatest challenges for these companies is the lack of knowledge they have internally to face this transformation toward a service offering value in the manufactured products. A possible way to deal with this challenge is by looking for external service partners from the supply chain that can help to develop the required new competences and solutions. In this sense, we address the question of what kind of collaboration product companies should establish with the potential service suppliers to achieve more benefits from Servitization. Thus, we study the contribution of three different configurations of service suppliers' involvement – White Box (buyer-driven service design), Grey Box (joint service design) and Black Box (supplier-driven service design) – on three different business dimensions for Servitization (service offering, resource base and activity system) and on the resulted benefits from Servitization. This was studied by means of a cross-sectional quantitative survey in 104 Brazilian and Italian product companies. Our findings show that grey box is the best collaboration strategy, while white and black have different contributions depending on the business dimension considered. We also discuss limitations on the supply chain for the implementation of each type of collaboration.

Keywords: Servitization; product-service systems; service suppliers' involvement; supplier collaboration; product companies.

1 Introduction

Product-firms are witnessing an increasing pressure to enter in the service field in order to maintain their competitiveness (BELAL; SHIRAHADA; KOSAKA, 2012b; TUKKER, 2004). Some companies follow this stream by moving to a product-service system (PSS) offering, other companies change the way products are offered by offering products as a service (PAAS) and others use internal competences from the manufacturing activities to develop new pure services business units. All these options are different forms of a service innovation process in product-firm which is named 'Servitization' (VANDERMERWE; RADA, 1988). Servitization comprises a business model transformation where services acquire a new dimension and priority in a product firm aiming to offer more complete solutions to their customers (BRAX; VISINTIN, 2016; KOHTAMAKI et al., 2013).

However, this is frequently an unknown field for product-firms, which have lack of knowledge and capabilities to offer services (GALBRAITH, 2002; NEU; BROWN, 2005). Therefore, such companies may need the help of external partners to be able to offer such solutions demanded by the market (MARTINEZ et al., 2010; WINDAHL; LAKEMOND, 2006). Some authors agree that, for such a need, the companies should look at their supply chain in order to identify potential service knowledge sources (e.g. BASTL et al., 2012; SACCANI; VISINTIN; RAPACCINI, 2014). Other authors defend that companies should move beyond the current supply chain configuration by looking for opportunities at several service potential partners that are not participating currently of the company's main business (AYALA et al., 2016; JOHNSON; MENA, 2008; LOCKETT et al., 2011). In this sense, we understand as potential service suppliers any service partner – independently of being currently or not part of the company's supply chain – that can provide to the company's customers a service solution compatible to the main company's product offer. These companies can be dedicated to different types of industrial services like logistics, maintenance, consulting, software solutions, data analysis and many other services that can contribute to the value proposition of the product-firm who is intending to become servitized (FINNE; HOLMSTRÖM, 2013; KARATZAS; JOHNSON; BASTL, 2017).

When product-firms work in a partnership with service providers to be able to offer product-service solution for the customers, these three parts constitute a service triad (LI; CHOI, 2009; SILTALOPPI; VARGO, 2017). The service triad theory has raised and became a noticeable topic in supply chain management and operations management literature

(KOWALKOWSKI; KINDSTRÖM; CARLBORG, 2016; WYNSTRA; SPRING; SCHOENHERR, 2015). The relationship between product company and service provider for the development and delivery of a PSS in a triad is more complex than the traditional dyadic relationship observed in a product supply chain (KOWALKOWSKI; KINDSTRÖM; CARLBORG, 2016; WYNSTRA; SPRING; SCHOENHERR, 2015). In a new product development (NPD) process, buyer and suppliers can be involved in different configuration types (PETERSEN; HANDFIELD; RAGATZ, 2005; RAGATZ; HANDFIELD; SCANNELL, 1997), each of them having different impacts in the benefits obtained from the NPD process (LE DAIN; MERMINOD, 2014; RAGATZ; HANDFIELD; PETERSEN, 2002). However, the types of relationship with service suppliers have not been yet explored in the service triad and servitization contexts. Prior research has studied the product company-service provider relationship without considering the possible variations of collaboration types (e.g. FINNE; HOLMSTRÖM, 2013; KARATZAS; JOHNSON; BASTL, 2016; LI; CHOI, 2009). However, in a service triad for servitization, the type of buyer-supplier configuration could have an important influence in the activities and results obtained from servitization, as it happens in the traditional NPD process as well (HANDFIELD et al., 1999). In this sense, we assume that some collaboration types with service providers can be more effective than others for the servitization strategy of a product-firm, which is expressed in the following research question: *which is the most effective collaboration type in a service triad aiming for a servitization strategy of the product-firm?*

To answer this research question, we analyze the contribution of three different types of service supplier involvement for the servitization business development and for the benefits obtained. This investigation is made by means of a survey in 104 Brazilian and Italian product companies engaged in service offering activities. For this analysis, we adopt the classic supplier involvement typology from the supply chain and new product development literature to classify service suppliers into three main forms of cooperation: white, grey and black box configuration (PETERSEN; HANDFIELD; RAGATZ, 2005). We analyze the contribution of these three types of configuration for the business systems dimensions as well as for the servitization benefits obtained. In this sense, we consider three main business system dimensions of the product companies that can be benefited from service suppliers: (i) the offering dimension; (ii) the resource base dimension; and (iii) the activity system dimension. Our results demonstrate that grey box has a stronger impact on the servitization business dimensions and on the performance obtained, but is also the most risky and difficult

collaborative approach to be established. Our findings enhance the discussion about the role of service providers in the servitization process and shed light on the relationships that product-firms need to build with their service partners in a service triad.

The remaining sections are organized as follows. First, we start presenting a theoretical background and hypotheses development for the importance of collaboration between buyer (product company) and supplier (service providers) in a context of a service triad for servitization and the impact in the business system dimensions. Next, in Section 3, we introduce afterwards the methodological aspects of this research. In Section 4 we summarize the findings of our study. Finally, in Section 5 we discuss the theoretical and practical contributions of this work, also presenting the limitations and a proposition of future research topics.

2 Theoretical background and hypotheses development

2.1 Service triads for servitization

When product-firms work in partnership with service providers in order to be able to deliver a joint solution to customers, these three parts compose a service triad, as presented in Figure 11 (FINNE; HOLMSTRÖM, 2013; WYNSTRA; SPRING; SCHOENHERR, 2015). One example of a service triad can be found in Karatzas et al. (2017). They present a case of a truck manufacturer who sell the trucks jointly with a service contract. Customers can pay a fixed amount of money per week to have access to a bundle for the truck, such as preventive maintenance, spare parts, breakdown attendance and telemetry technology for monitoring the performance of drivers. For the provision of these services, the manufacturer relies on independent service partners. However, the trucks are exclusively sold by the manufacturer, who also keeps contact with its business customers by his own key account managers. So, different from a product supply network, in a service context the manufacturer must permit a supplier to have also direct contact with its customers (LI; CHOI, 2009).

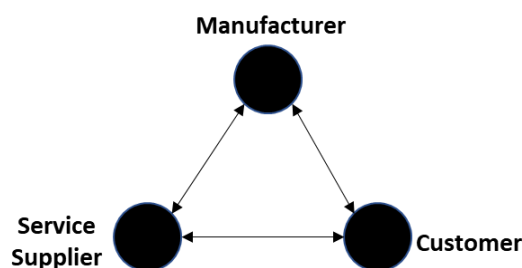


Figure 11: Service Triad (adapted from Wynstra et al. (2015))

Most of the studies on service triads have been dedicated to the context of pure service (KARATZAS; JOHNSON; BASTL, 2017). Only few prior works have analyzed the impact on performance or benefits of product company-supplier relationship in a service triad in a servitization context. By a systematical literature review of different types of triads, Siltaloppi and Vargo (2017) found that, in general, the coalitions among actors in a service triad influences the benefits obtained by companies. Karatzas et al. (2016) and Karatzas et al. (2017) used a configurational approach to qualitatively study the effect of product company-supplier on service performance, founding that performance varies according to how Cannon and Perreault's (1999) relationship dimensions are managed. Other authors found that the service supplier's performance is determinative for the loyalty and satisfaction of the customer, sometimes even more than the product companies performance (LI; CHOI, 2009; VAN DER VALK; VAN IWAARDEN, 2011). Additionally, Kowalkowski et al. (2016) observed that the value proposition is highly affected when product companies change from a dyadic to a triad relationship with its service partners.

All mentioned authors associated the performance of a PSS offering with the relationship between the product company and the service supplier, however, none of them have explicitly made a differentiation of the type of involvement between those actors. For instance, it is clear that the relationship presented by Wuyts et al. (2015), where the product company is almost purely outsourcing the service, is different from the one presented by Karatzas et al. (2017), where the product company is closely developing the service together with its service suppliers. Based on this, we propose an analogy with the three levels of buyer-supplier configurations proposed by Petersen et al. (2005) for pure NPD processes: (i) *White Box* (design is buyer-driven), (ii) *Grey Box* (joint design) and (iii) *Black Box* (design is supplier-driven). We propose that in the *White Box* configuration, the product-firm is responsible for the whole design and specification of the product-service solution and the service supplier is mainly involved in the late project stage, commonly the execution stage. In the *Grey Box* configuration, the design solution activity is strongly integrated and both actors have the same level of responsibility and importance in the design. Consequently, the product-firm and the service supplier work in deep collaboration from the beginning until the execution phase. Finally, in the *Black Box* configuration, the major responsibility falls on the service supplier, who is in charge of both designing and executing the product-service solution based on buyer's requirements and specifications.

Afterwards, based on these possible configurations and the impact on service performance suggested by previous authors, we propose that product-firms entering in a service triad can expect different benefits from the servitization according to the type of relationship configuration with their service suppliers, as we state in our hypothesis 1:

H1: Different levels of Servitization Benefits can be expected according to the type of service suppliers' involvement configuration adopted.

Moreover, several authors claim that the manner how product-firms are related with their service partners will have an impact on internal organizational aspects. Consequently, the implications of the type of configuration chosen on the business dimension of the product company must be also analyzed.

2.2 Organizational dimensions for servitization and the impact of service triad

Bigdeli et al. (2017) suggest that product-firms should consider three main aspects for a transformation towards servitization: the **content** of a chosen strategy, i.e. **what** changes; the **process** of change, which reveals various content alternatives, i.e. **how** it changes; and the **context** in which it occurs, i.e. **why** it changes. For the analysis of the organizational aspects affected by the relationship with service supplier, in this paper, we focus our attention specifically on the content (*what changes*) of the product company. Several authors have addressed three main system dimensions that can represent what changes in the business content (e.g. BÖHM; EGGERT; THIESBRUMMEL, 2017; GEBAUER et al., 2012; SANTAMARÍA; JESÚS NIETO; MILES, 2012; WIT; MEYER, 2010): (i) what focus should be adopted, (ii) what conditions are required, and (iii) which activities should be executed. These three dimensions were named as offering, resource base and activity system, respectively, based on Wit and Meyer (2010). The first dimension, *offering*, represents the form in which the product-firm decides to offer value to the customer based on PSS solutions. The second dimension, *resource base*, refers to the internal conditions needed to be able to offer the product-service solutions, such as knowledge and capabilities. Finally, the third dimension, *activity system*, considers the ability of the product company to develop and operationalize the product-service solutions.

The participation of the product-firm in a service triad may affect each of these business system dimensions, since the product company will rely on the service supplier for the development and delivery of the PSS solutions. At the *offering* level, the involvement with service suppliers can help product-firm to differentiate its products by new service perspective

(SACCANI; VISINTIN; RAPACCINI, 2014; WINDAHL; LAKEMON, 2006), based on the strategical understanding of service offering (KOWALKOWSKI; KINDSTRÖM; CARLBORG, 2016) and on a better identification of what means value for customers (LOCKETT et al., 2011). Product-firms are naturally more product-oriented (KOWALKOWSKI; GEBAUER; OLIVA, 2017), therefore, the interaction with service suppliers can bring more customer orientation and can allow them to respond faster to customer demands (BASTL et al., 2012; MATHIEU, 2001a).

Second, concerning the *Resource Base* dimension, product-firms can have own competences and knowledge needed to perform basic services related to the product usage (e.g. maintenance, process improvement, consulting). However, transforming such skills and knowledge into a service offering to the market can be hard, since employees are not use to deal with customers directly (ALGHISI; SACCANI, 2015; WINDAHL; LAKEMON, 2006). In this case, service suppliers emerge as an alternative once they can complement the existing knowledge with their service market understanding (CHIRUMALLA, 2013; LERTSAKTHANAKUN; THAWESAENGSKULTHAI; PONGPANICH, 2012; MEIER; ROY; SELIGER, 2010) as well as they can provide specific service skills (ALLEN; CHANDRASHEKAR, 2000; MATHIEU, 2001a). Moreover, the partnership with service suppliers can augment the flexibility of the product company to deal with new market demands while absorbing new service competences (LOCKETT et al., 2011; PAIOLA et al., 2013).

Finally, the activity system dimension implies the development of a superior PSS by integrating the customer demands with the knowledge from different business units, functional areas and services department in order to develop jointly service and products that will be part of the solution (LÖFBERG; WITELL; GUSTAFSSON, 2015; MATTHYSSENS; VANDENBEMPT, 2010). In this case, an early involvement of service suppliers with direct contact with customers and with more experience in service delivery can help companies to better integrate service and products into a joint solution (FINNE; HOLMSTRÖM, 2013; TULI; KOHLI; BHARADWAJ, 2007). As highlighted by Bastl et al. (2012) and Paiola et al. (2013), the ability to deliver complex PSS solution is hard to be developed by product-firms alone, being recommended a partnership with service providers. Product-firms that decide to innovate alone in the service domain, can stagnate in basic services such as maintenance and upgrades, losing opportunities to achieve radical service innovation (GALBRAITH, 2002; NEU; BROWN, 2005).

The aforementioned contributions and impact of suppliers' involvement on the business system dimensions of product-firm companies in prior works consider such collaboration in a generic manner. However, as explained before, the product-firm can choose between, at least, three levels of involvement with service suppliers: Black, Grey or White box. The choice of the type of service suppliers' involvement will depend on aspects like the financial objectives of the servitization and the desired level of contact with customers (SACCANI, 2012); the characteristics of service component (PAIOLA et al., 2013; SACCANI; VISINTIN; RAPACCINI, 2014); the complexity of the solution (FINNE; HOLMSTRÖM, 2013); the level of servitization (BIKFALVI et al., 2013), among others. Nonetheless, independently of the reason of the choice, we propose that the type of collaboration can contribute stronger or not to the levels of implementation of the three business dimensions explained. This is expressed in our second hypothesis:

H2: Different levels of development of the company business system dimensions (Offering, Resource Base and Activity System) can be expected according to the type of service suppliers' involvement configuration adopted.

The proposed hypotheses are represented graphically in Figure 12. By means of these two hypotheses, we aim to understand in this paper which collaboration type would be the most appropriate for the product-firm transformation toward servitization when the company has decided to work in a buyer-supplier relationship to this aim.

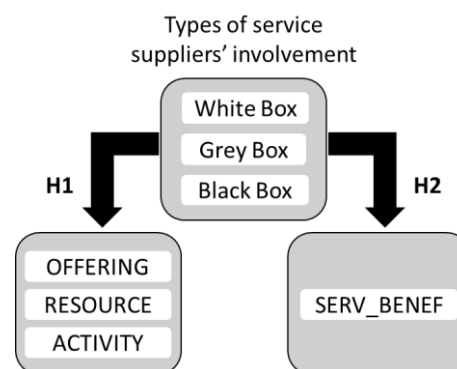


Figure 12: Research model

3 Research Method

3.1 Sample and data collection

To investigate the proposed hypotheses, we performed a cross-sectional survey in Brazilian and Italian product-firms engaged in the offer service solutions. We used data from

two different countries in order to enlarge our sample, since there is a natural difficulty to find product companies engaged in servitization because it is still a new trend in companies (BELAL; SHIRAHADA; KOSAKA, 2012a; BRAX; VISINTIN, 2016). We also considered two different economies, one emerging and other developed in order to consider different servitization contexts that could be compared. We obtained our sample from an industrial research network coordinated by two Universities from these countries. By means of this network, we had access to executives with engagement in the offering process of product-service solutions. We sent the questionnaire by e-mail to 347 Brazilian and 216 Italian product-firms and obtained a return of 213 answers (148 Brazilian and 65 Italian). From these, 104 useable questionnaires (an overall response rate of 18.47%). Table 9 shows the composition of the sample.

Table 9: Sample composition (n = 104 companies)

Category	Description	Num	(%)	Category	Description	Num	(%)
Industrial sector	Manufacturing	40	38,5%	Company's size	Small (<100 employees)	31	30%
	Construction	9	8,7%		Medium (100-500 employees)	21	20%
	Metallurgical	8	7,7%		Large (>500 employees)	52	50%
	Food	15	14,4%	Portfolio Distribution	More than 50% of services	19	18%
	Furniture	7	6,7%		More than 50% of products	85	82%
	Healthcare devices	2	1,9%	Business Focus	B2B	79	76%
	Hardware (IT)	7	6,7%		B2C	25	24%
	Others (<3 by industry)	17	16,3%	Supplier's Involvement	Black Box	26	25%
Business Country	Brazilian Companies	61	59%		White Box	23	22%
	Italian Companies	43	41%		Grey Box	55	53%

We first compared the subsamples of the two different countries using a T-test for the means of all variables include in the data collection. This was made to verify whether there is a national difference in the sample behavior. Our results indicated that the two subsamples does not present any statistical difference along the variables included in the data collection (t-test>1.9, p-value>0.05), which suggest that we can consider both subsamples in the final sample of analysis (HAIR et al., 2009).

We also evaluated the possible non-response bias in the sample. Aiming this, we evaluated the differences in the means of the early and late responses using the extrapolation technique that assumes that late respondents are most similar to non-respondents because their

replies took the most effort and the longest time (ARMSTRONG; OVERTON, 1977; WAGNER; KEMMERLING, 2010). The comparison between the first wave (n1=69) and the second wave of respondents (n2=35) by means of the Levene's test for equality of variances and the T-test for equality of means showed all p-values higher than 0.1, suggesting that the two waves did not differ in behavior.

3.2 Measures definition

Regarding the three product business dimensions, we represented them in constructs composed by multiple-item scales. Since there is little prior research on quantitative aspects on servitization (KOWALKOWSKI; GEBAUER; OLIVA, 2017), we created new scales based on different suggestions and empirical investigations from the literature. The *Offering* [OFFERING] dimension was represented as the composite of five items, we measured *Resource Base* [RESOURCE] dimension by four items and *Activity System* [ACTIVITY] dimension was operationalized by six items. The servitization benefits [SERV_BENEF] variable was measured also as a multiple-item scale that considers the service contribution for eight different items. Finally, the *Suppliers' Involvement configuration* [SUPPLIER] is a categorical variable based on the companies' statement about the main way they collaborate with service suppliers. In this sense, as explained above, we adopted the configuration types proposed by Petersen et al. (2005): (i) White Box (design is buyer-driven), (ii) Grey Box (joint design) and (iii) Black Box (design is supplier-driven). We have summarized the variables that compose the constructs and references in Table 10 and documented the complete questionnaire in Appendix A. We furthermore considered the percentage of portfolio distribution of product and service offerings and, because we were only interested in servitized companies, we discarded companies with absolute scales (only product or service offering). At the same time, since we aim to compare different types of suppliers' involvement, we discarded companies that do not collaborate with suppliers in the development and delivering of services.

Table 10: Items of the composite scales

Constructs	Main concept of the question (item)	Main references used for the construct
Offering [OFFERING]	Service as a competitive advantage	(BAINES et al., 2009a, 2010; BASTL et al., 2012; BUSTINZA et al., 2015; DAVIES, 2004; DESHPANDE; FARLEY; WEBSTER, 1993; EGGERT et al., 2013; GALBRAITH, 2002; LEONI, 2015; LOCKETT et al., 2011; MARTINEZ et al., 2010; MATHIEU, 2001a; PENTTINEN; PALMER, 2007; WINDAHL; LAKEMOND, 2010)
	Differentiation by services	
	Value added by services	
	Service to meet customer needs	
Resource Base [RESOURCE]	Customer orientation	(BAINES et al., 2009b; BARNETT et al., 2013; BRAX; JONSSON, 2009; GEBAUER et al., 2010; GEBAUER; GUSTAFSSON; WITELL, 2011; HELFAT; PETERAF, 2003; JOHNSTONE; DAINTY; WILKINSON, 2009; KIMITA et al., 2015; KREYE; ROEHRICH; LEWIS, 2015; LEONI, 2015; MATTHYSSENS; VANDENBEMPT, 2010; NEU; BROWN, 2005; SLACK, 2005; TULI; KOHLI; BHARADWAJ, 2007)
	Internal development of new competences	
	Individual expertise for service offering	
	Internal flexibility	
Activity System [ACTIVITY]	Internal knowledge related to services processes	(BAINES et al., 2010; BIKFALVI et al., 2013; DURUGBO, 2014; DURUGBO; RIEDEL, 2013; JOHANSSON; OLHAGER, 2004; KINDSTRÖM; KOWALKOWSKI, 2009; MONT, 2002; PASLAUSKI et al., 2016; RADDATS; KOWALKOWSKI, 2014; SLACK, 2005; SZWEJCZEWSKI; GOFFIN; ANAGNOSTOPOULOS, 2015; TULI; KOHLI; BHARADWAJ, 2007)
	Joint development of products and services	
	Involvement of service area in the NPD process	
	Involvement of functional areas in solution development	
	Involvement of customers in solution development	
Service Suppliers' Involvement [SERV_SUPP]	Involvement of other BU in solution development	(PETERSEN; HANDFIELD; RAGATZ, 2005)
	Solution customization	
	Black Box (buyer-driven service design)	
Servitization Benefits [SERV_BENEF]	White Box (joint service design)	(BAINES; SHI, 2015; GEBAUER; GUSTAFSSON; WITELL, 2011; LOCKETT et al., 2011; MATHIEU, 2001a; MONT, 2002; ORDANINI; PARASURAMAN, 2010; PENTTINEN; PALMER, 2007; RADDATS; BURTON; ASHMAN, 2015; VANDERMERWE; RADA, 1988; WINDAHL; LAKEMOND, 2010)
	Grey Box (supplier-driven service design)	
	Service contribution for new product sales	
	Service contribution for new product development	
	Service contribution to access new customers with extant products	
	Service contribution to access new markets with extant products	
	Service contribution to customer loyalty	
Service contribution to adapt products to customers' needs		
Service contribution to innovation	Service contribution to innovation	(BAINES; SHI, 2015; GEBAUER; GUSTAFSSON; WITELL, 2011; LOCKETT et al., 2011; MATHIEU, 2001a; MONT, 2002; ORDANINI; PARASURAMAN, 2010; PENTTINEN; PALMER, 2007; RADDATS; BURTON; ASHMAN, 2015; VANDERMERWE; RADA, 1988; WINDAHL; LAKEMOND, 2010)
	Service contribution to value added to customers	

3.3 Construct Validity

We followed several techniques suggested by Podsakoff et al. (2003) to reduce the risk of common method bias. First, we randomized the questions' to avoid that the respondent may directly associate variables that could be expected to have a relationship. In addition, we sent our questionnaire to key respondents. All of them are engaged in the activities related to the product-service solution offering. Finally, we calculated the Harman's single-factor test with an exploratory factor analysis to address common method bias (PODSAKOFF et al., 2003). This test with all independent and dependent variables resulted into a first factor that comprehended only 15.37% of the observed variance. Therefore, since there was no single factor accounting for the majority of the variance in the model, this test indicated that common method bias could not be a problem in the sample. However, as highlighted by (GUIDE; KETOKIVI, 2015), it is not possible to conclude about the absence of common method variance since the only certain way to avoid this is problem is by considering several respondents for each company. Thus, we took all the possible precautions but we have still a usual limitation of survey studies.

Additionally, for the multi-item constructs (OFFERING; RESOURCE; ACTIVITY and SERV_BENEF) we validated uni-dimensionality by means of a confirmatory factor analysis (CFA). This test indicated satisfactory fitness of each multiple-item construct proposed, as presented in Table 11. We also demonstrate in this table the composite reliability and Cronbach's alpha values of the variables. All items strongly loaded on their constructs (factor loading p -value < 0.01). The construct reliability exceeded the usual acceptable level of 0.7. We detailed these results in Table 11.

We also tested discriminant validity based on Bagozzi et al. (1991) who suggested a series of two-factor model estimation. For each pair of possible constructs, we performed two CFA models and compared their goodness of fit. In the first model, we restricted the correlation between the two constructs to unity while in the second model we freed this restriction and calculated the goodness of fit for the original constructs. In this test the overall results showed discriminant validity ($\Delta\chi^2 > 3.84$, p -value < 0.05 ; Bagozzi et al., 1991).

Table 11: Confirmatory Factor Analysis results

	SUPPLIER	OFFERING	RESOURCE	ACTIVITY	SERV_BENEF
CFI	--	0.979	0.996	0.969	0.994
RMSEA	--	0.067	0.036	0.062	0.064
Cronbach's Alpha	--	0.752	0.735	0.755	0.852
Composite Reliability	--	0.760	0.701	0.755	0.855

3.4 Data analysis

We used two different multivariate techniques for data analysis. First, we used a one-way Analysis of Variance (ANOVA) to test the hypothesis H1. This hypothesis analyses whether there are differences between the types of supplier involvement (i.e. Black Box, White Box and Grey Box) when considering the performance of the companies, measured as the servitization benefits obtained. As result, we tested one ANOVA model considering the supplier involvement configuration as a categorical independent variable and the servitization benefits as a single dependent variable. Assumptions of normality and homoscedasticity were tested for the servitization benefits (HAIR et al., 2009). We examined the residuals to confirm normality of the error term distribution and we evaluated homoscedasticity by plotting standardized residuals against predicted value and examining visually. These tests confirmed the two assumptions for univariate data analysis.

On the other hand, Multivariate Analysis of Variance (MANOVA) test was used to evaluate the hypothesis H1 that analyses the potential differences between three types of supplier involvement configuration (i.e. Black Box, White Box and Grey Box) when considering the degree of development of three output variables: the business dimensions for servitization (i.e. offering, resource base and activity system). As result, we tested one MANOVA model considering the supplier involvement configuration as a categorical independent variable and the three business dimensions as the dependent variables. Assumptions of normality, linearity and homoscedasticity were tested for the business dimensions (HAIR et al., 2009). We examined the residuals to confirm normality of the error term distribution. Linearity was tested with plots of partial regression for each dependent variable. Finally, we evaluated homoscedasticity by plotting standardized residuals against predicted value and examining visually. These tests confirmed the three assumptions for multivariate data analysis. Statistical analyses for both tests were performed with SPSS Statistics® version 18.

4 Results

To test the hypothesis H1, which relates the service suppliers' involvement types with the servitization benefits, we performed a one-way ANOVA test where the differences of means of Servitization Benefits (dependent variable) were analyzed for the three types of suppliers' involvement (independent variable). These results are presented in Table 12. As shown in this table, the model was significant (F-value = 10.50, $p < 0.001$), supporting our proposed hypothesis H1. The pairwise comparison (LSD test) indicates that the three configurations are statistically different and each of them represents a different level of benefits obtained from servitization. Particularly, Grey Box configuration of service supplier involvement allows companies to achieve a higher performance when compared to Black and White Box. On the other hand, companies that are using the Black Box configuration for supplier involvement presented the worst results for servitization benefits.

Table 12: ANOVA test for the effect of the service suppliers' involvement on the servitization benefits (n=104)

Dependent Variable (Business Performance)	Means and Standard Deviation			ANOVA F-value	Pairwise Comparisons (LSD test)
	Black Box (1)	White Box (2)	Grey Box (3)		
Servitization Benefits	2.99 (± 0.85)	3.43 (± 0.65)	3.75 (± 0.63)	10.506***	[1,2]** [1,3]*** [2,3]**
Sample size (n)	26	23	55		

Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Regarding the hypothesis 2, we performed the Box's test of equality of covariance for the MANOVA model that considers the level of contribution of the three types of suppliers' involvement in the three different business dimensions for servitization. The Box's tests was not significant ($p\text{-value} > 0.1$), which means that the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups could not be rejected, allowing proceeding with the MANOVA test. Then, we performed the Wilks' Lambda test for the proposed MANOVA model, which showed that the model was statistically significant ($F=3.163$, $p\text{-value} < 0.01$). This means that there are statistical differences in the degree of development of the business model dimensions when considered the type of suppliers' involvement for servitization. Therefore, the hypothesis H2 was supported by our empirical findings.

After performing the general MANOVA test, we proceeded with a set of ANOVA tests, where the differences of means for all levels of the independent variable (types of suppliers' involvement) were tested for the three business dimensions (OFFERING; RESOURCE; ACTIVITY). Before performing the ANOVA test, we first applied the Levene's test of equality of error variances. For all models, Levene's test did not show significance in the dependent variables, which means that we can assume that the error variance of the dependent variable is equal across groups, allowing to proceed with the ANOVA test.

Table 13 summarizes the results of the ANOVA tests and the significant pairwise comparison (LSD post-hoc analysis) for de MANOVA Model. According to the results of Table 13, H2 is supported, since there is a significant differentiation for the three types of suppliers at the three businesses. The pairwise comparisons results show that companies achieve a better development of the three business dimensions when they use a Grey Box configuration with service suppliers. Furthermore, for OFFERING business dimension, White Box seems to be an intermediate option (however, it did not show statistical differences from the other two configurations), followed by the Black Box configuration. On the other hand, for RESOURCE and ACTIVITY, White Box configuration did not show significant difference from the Black Box configuration.

Table 13: ANOVA test for the effect of service suppliers' involvement on the product business dimensions of Servitization (n=104)

Dependent Variable (Business Dimensions)	Means and Standard Deviation			ANOVA F-value	Pairwise Comparison (LSD test)
	Black Box (1)	White Box (2)	Grey Box (3)		
OFFERING	3.01 (± 0.93)	3.44 (± 0.85)	3.62 (± 0.72)	5.051***	[1,2]* [1,3]***
RESOURCE	3.37 (± 0.81)	3.37 (± 0.77)	3.85 (± 0.72)	5.149***	[1,3]*** [2,3]**
ACTIVITY	2.76 (± 0.72)	2.95 (± 0.87)	3.35 (± 0.67)	6.357***	[1,3]*** [2,3]**
Sample size (n)	26	23	55		

Notes: ***p<0.01; **p<0.05; *p<0.1

5 Discussions and Conclusions

5.1 Theoretical contributions

Recently, researchers from supply chain management, operations management and marketing have increased their attention on service triads to better understand the servitization phenomena (KARATZAS; JOHNSON; BASTL, 2016; KOWALKOWSKI; KINDSTRÖM; CARLBORG, 2016; SILTALOPPI; VARGO, 2017; WUYTS; RINDFLEISCH; CITRIN, 2015; WYNSTRA; SPRING; SCHOENHERR, 2015). Our study extends and enriches this research field, by presenting a quantitative survey study that analyzed three different types of collaboration that companies can use to collaborate with service partners in order to obtain benefits from servitization. Considering the fact that most of the studies on service triad for servitization have been based on qualitative data or theoretical proposition, our empirical quantitative results help to enlarge the current understanding of this strategical approach. Our findings support prior suggestions in the extant literature that the form in which product companies involves its service suppliers can affect the company's results (e.g. KOWALKOWSKI; KINDSTRÖM; WITELL, 2011; WYNSTRA; SPRING; SCHOENHERR, 2015) and its PSS performance (e.g. FINNE; HOLMSTRÖM, 2013; PAIOLA et al., 2013).

This work contributes to the supply chain literature concerned with servitization by adding more granularity to the state-of-the-art by detailing the supplier involvement type using Petersen's et al. (2005) buyer-supplier configurations: White Box (design is buyer-driven), (ii) Grey Box (joint design) and (iii) Black Box (design is supplier-driven). The existing literature on servitization has treated the collaboration with suppliers as something unique, without discriminating the collaboration types. In this paper, we demonstrated that suppliers' involvement for servitization can be managed in different forms according to companies' objectives. Our empirical data showed that for all business system dimensions (Offering, Resource Base and Activity System), Grey Box presents a better level of development of such dimensions. Consequently, as expected, Grey Box showed also a better performance in terms of the Servitization benefits obtained. In Grey Box configuration, the collaboration between partners is more intensive and knowledge flows in both directions (AYALA et al., 2016; LE DAIN; MERMINOD, 2014). In this sense, our results reinforce Kowalkowski et al. (2011) suggestion that it is important that the product company internalize the servitization aspects instead of just outsourcing the service components.

This work also contributes to the service triad literature by demonstrating that Grey Box configuration is an alternative path to avoid the risk of outsourcing service activities presented by Wynstra et al. (2015) and, also, the undesired situation presented by Li and Choi (2009) that benefits for product companies erode when their bridge position decay in service triads. Furthermore, our study answer the questions raised by Wynstra et al. (2015) regarding the extent to which it makes sense for product-firms to develop some capabilities related to service delivery (Grey Box) instead of just outsourcing to service suppliers (Black Box), demonstrating that benefits obtained from servitization increase in the first case. At the same time, we quantitatively confirmed Finne and Holmström's (2013) findings from a single case study that a close cooperation between product company and service provider (here defined as a Grey box) in a triad improves the value to customers and, as our results showed, it brings also other benefits than a simple outsourcing of service delivery. Therefore, such findings also respond to (MENA; HUMPHRIES; CHOI, 2013) claim for more research focused on the link between the buyer-supplier relationship dynamic in a triad and its performance.

5.2 Managerial Implications

The results of this study are relevant for managers of product-firms who want to become servitized. Specifically, Lockett et al. (2011) suggested that the adoption of a servitized business model can have a negative effect on companies if the relationship with suppliers is not correctly defined. But how should a company define such a relationship? Our results shed light on this matter, showing that when product companies choose to enter in a service triad to implement a servitized business model they should focus on a joint product-service system design (Grey Box configuration) with service suppliers. This can help the company not to become just dependent from other partners but to develop its own new capabilities and structure (PAIOLA et al., 2013). As a result, product companies working in a Grey Box configuration will be able to achieve higher degrees of integrated PSS solutions while avoiding the problem of misalignment between product and service design, which usually make difficult to develop effective solutions for customers (Martinez et al. (2010)). Another point is that when product-firms chose to work alone, they usually offer only basic services, since they are limited to their own capabilities (GALBRAITH, 2002; NEU; BROWN, 2005), something that can be avoided by Grey Box collaboration.

However, even when our results indicate Grey Box as the best alternative of service suppliers' involvement for servitization, we must note that the company's contextual

conditions have not been considered in this work. This means that, in the end, the type of configuration to be chosen will depend on the strategic decisions that the company makes (GEBAUER; FLEISCH; FRIEDLI, 2005; MATHIEU, 2001a). Independently of which configuration brings more long-term results, Black Box, for instance, is an immediate alternative for product-firms that want to become servitized. This is because they can outsource all the service design and development process without needing internal efforts and structure for the service domain (BUSTINZA; ARIAS-ARANDA; GUTIERREZ-GUTIERREZ, 2010; ELLRAM; TATE; BILLINGTON, 2008). Our results indicate that Black Box has the lower level of benefits as well for the Servitization strategy, but since it is the most immediate way to collaborate, it could be proposed as an initial option to involve service suppliers. One problem of Black Box configuration is that the company is developing few, if any, service capability internally, being highly dependent from its service suppliers to create new services (ELLRAM; TATE; BILLINGTON, 2008; LI; CHOI, 2009). Therefore, the little contact with the service domain reduces the chance of increasing the own resource base and activity capacities of the company. The product-firm will still have lack of service knowledge as well as superficial relationship with the customers, which also affects the ability to recognize rapidly new demands (DATTA; ROY, 2011).

Secondly, White Box is a more feasible alternative for large companies that have the possibility to hire people with the necessary capabilities to self-design the services that will be simply executed by the service supplier. In this case, the product company is forced to develop all service development capabilities internally which naturally means being less flexibility since this is more time consuming and, at the same time, it increases the business risks (PAIOLA et al., 2013; SLACK, 2005). Therefore, from the perspective of our results, this seems to be not a good option for companies because it demands a strong internal effort and the results indicate that it does not compensate with the resulting benefits when compared to the other types of relationship. However, some companies could choose such a strategy when they want to centralize the decision making and to be more independent from service suppliers. In such cases, the company perceive the ownership of its expertise as a key differentiator that can make it capable to offer the servitized solution (KOWALKOWSKI; KINDSTRÖM; WITELL, 2011). However, this configuration could be the most difficult scenario for product-firms since the service supplier is involved only in the delivery phase, when the complete solution has been already designed (BAXTER et al., 2009; BRAX, 2005)

and when the product-firm has already faced most of the development risks and efforts by itself.

Finally, Grey Box configuration can allow the most flexible and, therefore, complete solution, since it is the only alternative where the product is able to be modified during the joint PSS development (AYALA et al., 2016), leading to a more radical business model innovation and better servitization benefits, as shown in our results. Nonetheless, the implementation time for Grey Box may be long, since it requires a deeper analysis and definition of the collaboration criteria, the decision-making process between the partners, among other aspects. Therefore, this approach could be part of a second-stage of the Servitization implementation, after trying first a Black Box configuration.

5.3 Limitations and future research

Our study has also some limitations that open opportunities for future research. First, the PSS benefits explored in this work do not include financial performance or sustainability benefits also presented in the literature as an important output of servitization; future studies can extend our analysis including these variables. Furthermore, we addressed the different types of configuration for collaboration with suppliers, but we are not discussing how companies could first identify potential service suppliers in order to choose the most adequate partner. As expressed by Pisano and Verganti (2008), the innovation partner selection is generally a big challenge for companies, even more when the company does not know what could be the solution and who could be the provider of such solution. In other words, when the company knows that collaboration is important for innovation, but it does not know what could be developed, it is harder to decide about a specific partner. This can be a challenge for 'pure' Grey Box configuration, where it is required that the partners develop a completely joint solution. Therefore, there is a dilemma before product-firms aiming for servitization: If they already have a preconceived idea about the product-service solution and then they decide who should be involved, then the solution can be limited to the own previous product knowledge restriction. On the other hand, if the product company does not have any preconceived idea about the solution, how it could know who should be involved as service supplier? In this context, product companies are entering in a new segment that they do not know and, more than this, they could have not a clear understanding of which service they can offer with its products. Consequently, we suggest for future research to explore this challenge,

since we started from the assumption that the company already knows which could be the service supplier involved in the service triad.

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7 Appendix A - Questionnaire

Questionnaire items to assess Offering [OFFERING]: *Concordance Likert scale:*

1-strongly disagree to 5-strongly agree.

- f) The service offering in my company is considered a strategical aspect for our competitiveness.
- g) We compete primarily in services differentiation.
- h) Our services are offered spontaneously when a customer need is identified.
- i) We understand well how our customer perceives the value of our services.
- j) We are more customer-oriented than our competitors.

Questionnaire items to assess Resource Base [RESOURCE]: *Concordance Likert*

scale: 1-strongly disagree to 5-strongly agree.

- e) To develop our services, we frequently develop new competences inside our company.
- f) The human capital (individual expertise) of my company is a source of competitive advantage.
- g) The internal knowledge owned by my company are considered source of competitive advantage.
- h) Our company is very flexible to deal with market changes.

Questionnaire items to assess Activity System [ACTIVITY]: *Concordance Likert*

scale: 1-strongly disagree to 5-strongly agree.

- g) Our services and products are developed together and simultaneously.
- h) The service area has an active role in taking strategic decisions about new products and markets.
- i) Our different functional areas work often together in the development of new products and solutions.
- j) Our clients have an active participation in the development of our new products and services.
- k) Our solutions are customized, attending to specific demands of our customers.
- l) Other business units of our company are very active in new product and service development.

Questionnaire items to assess PSS benefits: *Concordance Likert scale: 1-strongly*

disagree to 5-strongly agree.

- e) Our service solutions facilitate the sales of new products to our current customers.
- f) Our services solutions facilitate the development of new products for the market.
- g) Our services solutions allow us to reach new customers with the extant products of our portfolio.
- h) Our services solutions allow us to reach new markets with the extant products of our portfolio.
- i) Our service solutions help us to retain customers and to increase their loyalty.
- j) Our service solutions help us to adapt our products to customers' needs.
- k) Our service solutions are often seen as innovative by our customers.
- l) Our services solutions represent a significant value added to our customers.

Questionnaire items to assess Service Suppliers' Involvement [SERV_SUPP]:

Concordance Likert scale: 1-strongly disagree to 5-strongly agree. Formative scale (composite).

- f) *Non-collaboration*: The main services offered to our customers are developed and executed predominantly by our own company without any service partner.
- g) *Black Box collaboration*: The services offered to our customers are developed and executed predominantly by outsourced companies.
- h) *White Box collaboration*: The services offered to our customers are designed in our company, but their execution is outsourced.
- i) *Grey Box collaboration*: Suppliers are active partners in the development of new solutions for our products and services.

Questionnaire items for control variables:

- d) Please, inform the size of your company in number of employees.
- e) Please, describe your main business focus: (B2B; B2C; other).
- f) Please, describe how is composed your company's portfolio (in percentage): (products/services).

CONCLUSÕES GERAIS DA TESE

Esta tese teve como objetivo analisar a relação entre empresas de produto e fornecedores de serviços que trabalham em parceria dentro de uma estrutura de tríade de serviços com o objetivo de oferecer pacotes produto-serviço para seus clientes. Ao longo das três etapas de pesquisa conduzidas foi possível criar conhecimento a este respeito que trazem grandes contribuições tanto para o ambiente acadêmico-teórico quanto para o ambiente prático-gerencial, como apresentado a seguir.

Contribuições teóricas

Foi demonstrado nesta tese que, diferentemente de como é tratada na maioria da literatura de Servitização e PSS, a relação entre empresa de produto e fornecedor de serviços não deve ser generalizada e tratada de maneira simplista. Fruto do relacionamento com a teoria de integração cliente-fornecedor amplamente estudada na área de desenvolvimento de novos produtos, foi possível adaptar os tipos de configuração *black box*, *grey box* e *white box* para o contexto da Servitização. Esta adaptação permitiu entender e analisar de forma mais acurada esta relação.

Primeiramente, sob a perspectiva da gestão do conhecimento, esta tese forneceu uma estrutura teórica abrangente sobre os níveis de compartilhamento de conhecimento que podem ser esperados para cada tipo de colaboração entre empresa e fornecedor de serviços. Ainda, este estudo revelou uma relação entre a inovação do modelo de negócio e implementação da servitização que ainda não estava explícita na literatura. As descobertas mostraram que a visualização das tipologias de colaboração empresa e fornecedor através das lentes da pesquisa da inovação do modelo de negócio (que se concentra nas modificações na arquitetura de valores da empresa) pode permitir uma compreensão mais profunda desse problema de pesquisa. Além disso, foram descobertos comportamentos diferentes entre a colaboração tradicional empresa-fornecedor no desenvolvimento de produtos e a colaboração na inovação do modelo de negócios para a servitização. Foi descoberto que a dinâmica do compartilhamento de conhecimento depende não apenas do tipo de colaboração, mas também do tipo de orientação de servitização, ou seja, se a inovação do modelo de negócio é orientada para produtos ou serviços. Assim, foram obtidas seis formas de dinâmica do compartilhamento do conhecimento para Servitização, em vez de apenas três, como discutido na literatura existente de desenvolvimento de novos produtos. As descobertas deste trabalho

também sugerem que apenas uma das seis configurações envolve uma alta intensidade de transformação do conhecimento (*grey box* para PSS orientado a serviços), enquanto todas as outras combinações são restritas aos níveis de transferência e tradução do conhecimento.

Em segundo lugar, a pesquisa contribui para a literatura de Servitização com uma compreensão mais fina do impacto do envolvimento dos fornecedores de serviços, permitindo uma melhor compreensão de como envolver esses parceiros de acordo com os objetivos estratégicos da empresa de produto. Nesta tese foi demonstrado que o envolvimento dos fornecedores para a servitização pode ser gerenciado de diferentes formas de acordo com os objetivos das empresas. Os dados empíricos mostraram que para todas as dimensões do negócio uma configuração *grey box* apresenta um melhor nível de desenvolvimento de tais dimensões. Ainda, a configuração *grey box* também mostrou um melhor desempenho em termos dos benefícios obtidos da Servitization.

Uma última contribuição está relacionada ao campo da pesquisa emergente em tríades de serviço. Foi demonstrado nesta pesquisa que o comportamento de uma tríade de serviço no contexto de servitização varia de acordo com a orientação da estratégia de servitização que o fabricante segue. Esta descoberta complementa pesquisas prévias nos campos de gestão da cadeia de suprimentos e gerenciamento operacional, que se concentraram apenas na servitização orientada a produtos. Ainda, foi demonstrado que a configuração de envolvimento de fornecedores *grey box* é um caminho alternativo para evitar o risco de atividades de serviços de terceirização e, também, a situação indesejada onde os benefícios para os fabricantes se corroem quando sua posição de ponte se deteriora em tríades de serviço. Além disso, nosso estudo responde as questões levantadas por autores da área de gestão de cadeias de suprimentos sobre em que ponto faz sentido para os fabricantes desenvolverem alguns recursos relacionados à entrega de serviços (*grey box*) em vez de apenas terceirizar para fornecedores de serviços (*black box*), demonstrando que os benefícios obtidos com a servitização aumentam no primeiro caso.

Implicações práticas

Como as empresas de produto normalmente têm conhecimentos e capacidades limitadas sobre serviços, muitas vezes a decisão para os gestores não é se iniciar uma parceria com fornecedores de serviços ou não, mas a decisão de como colaborar com eles. Esta pesquisa contribui com uma compreensão mais acurada sobre como os benefícios que as empresas podem obter com a servitização são fortemente influenciados pela forma de

envolvimento dos fornecedores de serviços e a complexidade esperada para cada tipo de relação.

Foi demonstrado que os gerentes de empresas de produto devem estar conscientes da importância de selecionar parceiros e atribuir a eles papéis que se alinhem claramente aos objetivos estratégicos. Antes que os executivos escolham um tipo de colaboração com potenciais fornecedores de serviços, eles precisam ter cuidado em relação a dois aspectos principais. Primeiro, eles precisam avaliar não apenas o tipo de colaboração que desejam estabelecer, mas também a característica estratégica do modelo de negócio da solução proposta, voltada para produtos ou serviços, pois isso afetará diretamente a dinâmica da colaboração. Segundo, como consequência deste primeiro ponto, eles devem levar em consideração a complexidade da dinâmica de compartilhamento de conhecimento com a qual deverão lidar ao escolher uma dessas combinações.

Como mostrado pelos resultados desta pesquisa, gestores que desejam desenvolver soluções PSS mais fortes devem optar por uma colaboração *grey box*, mas isso pode exigir uma maior intensidade de KS com fornecedores, especialmente quando a solução é orientada para o serviço, o que resulta em tempos mais longos para definição e execução. Nesse caso, os gerentes não utilizariam os fornecedores de serviços para a terceirização das atividades, mas sim com o objetivo de construir conhecimento, inclusive com a possibilidade de um eventual *insourcing* no futuro. Como resultado, as empresas de produto que trabalham em uma *grey box* serão capazes de obter maiores níveis de soluções integradas de sistemas de serviços de produtos, evitando o problema de desalinhamento entre o design de produtos e serviços, o que costuma dificultar o desenvolvimento de soluções efetivas para os clientes.

No entanto, mesmo quando os resultados indicam a configuração *grey box* como a melhor alternativa, deve-se notar que as condições contextuais da empresa não foram consideradas neste trabalho. Independentemente de qual configuração traz mais resultados a longo prazo, a *black box*, pode ser uma alternativa mais imediata para as empresas de fabricação que precisam se tornar servitizadas por uma demanda do mercado. Os resultados desta pesquisa indicaram que a Black Box possui o menor nível de benefícios para a estratégia de Servitização, mas como é a maneira mais imediata de colaborar, pode ser proposto como forma inicial de envolver os fornecedores de serviços. Ainda, esta configuração requer níveis mais baixos de compartilhamento de conhecimento com fornecedores e a empresa não precisa desenvolver suas próprias capacidades de serviço. Porém, a proposta de valor do modelo de negócio do fabricante se torna mais dependente dos fornecedores de serviços.

Finalmente, a configuração *white box* aparece como uma alternativa mais viável para grandes empresas de fabricação que têm a possibilidade de contratar pessoas com as capacidades necessárias para desenhar internamente os serviços que serão simplesmente executados pelo fornecedor do serviço. Neste caso, a empresa de fabricação é forçada a desenvolver internamente todas as capacidades de desenvolvimento de serviços, o que naturalmente significa ser menos flexível, pois é mais demorado e, ao mesmo tempo, aumenta o risco de transformação. Neste caso, a dinâmica do compartilhamento de conhecimento com fornecedores de serviços é menos complexa, uma vez que se tornam meramente executores de serviço, mas o desafio é mais sobre como desenvolver internamente a competência do serviço.

Limitações e futuras pesquisas

O presente estudo se concentra na análise de três dimensões do negócio que foram identificadas como relevantes para uma implementação bem-sucedida da servitização. Contudo, existem outras propostas de dimensões clássicas dos modelos de negócios, como a de Osterwalder e Pigneur (2010) que propõe nove dimensões do modelo *CANVAS*. Essas propostas contemplam outras dimensões do negócio que não foram contempladas diretamente nesta tese e que poderiam ser estudadas em pesquisas futuras.

Ainda, os benefícios da Servitização explorados neste trabalho não incluem desempenho financeiro ou benefícios de sustentabilidade também apresentados na literatura como um importante resultado de Servitização. Estudos futuros podem ampliar a análise desta pesquisa, incluindo essas variáveis.

Por outro lado, os tipos de configuração da relação entre empresa de manufatura e fornecedor de serviço foram restritos à adaptação de um modelo amplamente difundido na área do desenvolvimento de novos produtos (modelo *White/Grey/Black box*). Contudo, existem outras estruturas de tipos de colaboração que poderiam ser avaliadas, sendo esta uma opção de delimitação da estrutura analítica do trabalho.

Por fim, este trabalho parte do pressuposto de que as empresas possuem um conhecimento prévio dos potenciais fornecedores de serviços que poderiam contribuir para o desenvolvimento da servitização. Em outras palavras, não se discute nesta tese como identificar fornecedores de serviços. A discussão está centrada no fato de entender como colaborar com fornecedores de serviços previamente identificados pela empresa. Assim sendo, futuras pesquisas poderiam também incluir o processo de identificação dos parceiros. Esta discussão pode estar baseada em teorias já estabelecidas como, por exemplo, a teoria de

capacidades de absorção (*absorptive capacities*) definida como a capacidade de uma empresa identificar conhecimentos externos úteis, assimilá-lo e aplicá-lo para fins comerciais (COHEN; LEVINTHAL, 1990; ZAHRA; GEORGE, 2002).

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