Antecedents of servitization strategies in manufacturing firms and servitization's impact on firm performance: a theoretical and empirical analysis

Antecedents of Servitization Strategies in Manufacturing Firms and Servitization's Impact on Firm Performance

A Theoretical and Empirical Analysis

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of the University of West London

Declaration

This thesis is the result of my own work and includes nothing that is the outcome of collaboration with others. It has not been submitted in whole or in part for a degree at any other university. Some of the work has been published previously in conference proceedings and journal articles. All sources of quoted information are acknowledged by means of references. The length of this thesis, including appendices, references, footnotes, tables and equations, is approximately 80,000 words and it contains 61 tables and 24 figures.

Mohamad Aboufoul

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Abstract

Manufacturing firms have vigorously pursued opportunities for profitability and growth through service-led growth strategies. A major part of the existing literature has focused on such strategies and has shown that this phenomenon is prevalent and growing in most developed economies.

However, very little systematic evidence regarding the extent or consequences of servitization, based on comprehensive survey research, yet exists. Furthermore, the current body of research presents contradictory findings regarding the impact of servitization on firm performance. Drawing on the theoretical framework of the resource-based view, this research seeks to shed some light on this question by exploring the effect of servitization on firm performance. Through a survey of 185 U.S. and European manufacturing firms, along with the use of secondary financial data, this thesis provides empirical evidence that servitization has a direct, positive effect on firm performance. The study also finds that for the vast majority of manufacturers, the development of learning capabilities has served as a significant driver of servitization. Furthermore, the relationship between servitization and firm performance is moderated by industry dynamism.

The original contribution of this research to the field of knowledge is twofold, including a theoretical contribution through the validation of the theoretical model and its implications for the literature, and a pragmatic contribution through the managerial implications of the findings. The findings have significant managerial implications because achieving superior bottom-line results is contingent upon the integration of those learning- and service-specific capabilities that transform the nature of an offering. Such integration enables the manufacturing firm and its customers to achieve radically improved operation within their ecosystems.

Keywords: servitization, firm performance, structural equation modelling, resource-based view.

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Acronyms

AI	Artificial Intelligence
AMOS	Analysis of Moment Structures
AVE	Average Variance Explained
B2B	Business to Business
BSC	Balanced Scorecard
CEO	Chief Executive Officer
EPS	Earnings Per Share
Cf.	Confer
CFA	Conformity Factor Analysis
CMS	Chemical Management Services
CMV	Common Method Variance
C-OAR-SE	Construct definition, Object and Attribute classification, Rater identification, Scale formation and Enumeration
CR	Composite Reliability
CSV	Substantive Validity Assessment
CVI	Content Validity Index
DCT	Dynamic Capabilities Theory
df	Degrees of Freedom
DN	Deductive-Nomological
DV	Dependant Variable
EFA	Exploratory Factor Analysis
e.g.	Exempli gratia (for example)
Fig	Figure
EVAC	Economic Value-Added Change rate
G2	Second Generation
GDL	Goods Dominant Logic
Gof	Goodness of Fit
IB	Installed Base
ICT	Information and Communication Technology

IO	Industrial Organization
IOT	Internet of Things
IP	Intellectual Property
IV	Independent Variable
KIS	Knowledge Intensive Services
KMO	Kaiser-Meyer-Olkin
LISREL	Linear Structural Relationship
LV	Latent Variables
MANOVA	Multivariate Analysis of Variance
MSA	Measure Sampling Adequacy
n	Sample size
NIH	Not Invented Here
NPD	New Product Development
NS	Not Significant
OBCs	Outcome-Based Contracts
p. / pp.	Page(s)
PCA	Principle Component Analysis
PLS	Partial Least Squares
PRL	Proportional Reduction in Loss
PSA	Proportion of Substantive Agreement
PSS	Product Service System
R&D	Research and Development
RBV	Resource-Based View (of the firm)
RMS	Remote Monitoring Systems
ROA	Return on Assets
ROI	Return on Investment
ROS	Return on Sales
SBM	Servitization Basic Model
SD	Standard Deviation
SDL	Service Dominant Logic
SEM	Structural Equation Modelling
SPC	Structure-Conduct-Performance Paradigm
SPSS	Statistical Package for Social Science
TCE	Transaction Cost Economics

VAF	Variance Accounted For
VCC	Value Co-creation
VIF	Variance Inflation Factor
VRIN	Value, Rareness, Inimitability and Non-substitutability

Notations

β	Beta Path Coefficient
D	Certain Omission Distance
f^2	Effect Size
R^2	Coefficient of Determination
q^2	Effect Size
Q^2	Predictive Relevance
log(x)	Natural Logarithm of x
P	Significance Level
∝	Cronbach's Alpha
η	Latent Endogenous Variable
ξ	Latent Exogenous Variable
ε	Error Term for an Indicator y
δ	Error Term for an Indicator X
ζ	Error Term for a Latent Endogenous Variable
Γ	Matrix Γ Contains the Coefficients of the y's on the x's
Λ	Loadings Matrix of Indicators

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Journals

Paper 1. Aboufoul, M. and Ruizalba, J. (2nd round review). Servitization: Toward a Conceptual Framework. *The Service Industries Journal.* (ABS, 2)

Paper 2. Aboufoul, M., Ruizalba, J., and Soares, A. (Under review). The impact of Digitalization and Servitization on the Financial Performance of the Firm: An Empirical Analysis. *Journal of Business Research*. (ABS, 3)

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CHAPTER 1

Introduction

1.1 Background

In the early seventies, an article by Levitt (1972) published in the Harvard Business Review argued that "everybody is in service." In this seminal article, the author claimed that the current services taxonomy was obsolete and that the services spectrum should therefore be broadened to include all types of services, especially those provided by manufacturing firms. Addressing the service marketing field, Grönroos (2000) equally suggested that it is not beneficial to try to classify customers based on whether they are buying products or services; customers are paying for the value and benefits that both products and services provide them with.

Indeed, within developed countries, services are widely considered the largest and often fastest-growing sector (Triplett and Bosworth, 2004), and service firms comprise a significant and growing proportion of the largest firms (Heskett, 1986). To highlight the impact of services on the economy, Quinn et al. (1990) and Chesbrough and Spohrer (2006) investigated the economic activities of developed countries, and found the economies of these countries to already be dominated by services.

Furthermore, Salter and Tether (2006) argued that industrialised nations are well advanced in terms of research and development (R&D) expenditures in the service sector, with more than 30 percent of total R&D expenditures dedicated to services. While most of the service literature concerned with manufacturing is still dominated by the logic emphasising that customer value is embedded within the physical artefact and underpinned by discrete transactions (Rust and Mui, 2006), Vargo and Lusch (2004) challenged this narrow perspective, arguing that value is realised when the customer actually uses the products. Nevertheless, in the academic discourse regarding both industrial marketing and operations management, discussions of the 'transition to service' undertaken by manufacturing firms have proliferated (Wilkinson, Dainty and Neely, 2009).

An important body of research has asserted that services play a pivotal role in product-based firms in mature industry sectors. Likewise, in his seminal work, Teece (1986) emphasised that services "do not loom large" in the early stages of an industry (p. 251). After the onset of maturity, product firms should shift their innovation focus away from products to services in order to compete through process innovation and efficiency (Suarez et al., 2013; Klepper, 1996).

The argument is that manufacturers, encountering growing commoditisation of their businesses, ought to consider service offerings as a way to capture new revenue streams, differentiate themselves, create value and increase profitability (Spring and Araujo, 2013). Furthermore, in manufacturing markets, services have often been regarded as an add-on to the core product offering and as a necessary evil in order to ensure future product sales (Robinson et al., 2002).

The transition from manufacturing to services is conventionally known as 'servitization,' a term first coined by Vandermerwe and Rada (1988). The accounts of the servitization literature are predominantly concerned with a shift in the vertical scope of firms' activities from those typically considered as manufacturing according to standard industry categorisations to activities equally categorised as services, such as maintenance, spares provision and condition monitoring, also known as ancillary services (Spring and Araujo, 2013).

Such a transition is viewed as an alteration to the division of labour within a value chain that is otherwise presumed to be mostly static, with the manufacturer taking over activities previously carried out by its customers in order to deliver trouble-free operation for the customers. Such additional services might be sold separately, or under arrangements based on the 'rental/asset paradigm' of service (Lovelock and Gummesson, 2004), which involves the retention of ownership of the asset (typically a capital asset) by the firm that has manufactured it, and the provision of access to the asset rather than giving users outright ownership (e.g. Doerr, Lewis and Eaton, 2005).

A classic example of such a transformation is aero engine manufacturer Rolls-Royce plc, which now sells its jet engines along with the services to maintain, repair and upgrade them over many years, known as the "Power by the Hour" program. New service contracts now account for more than 50% of Rolls-Royce's revenues (Rolls-Royce, 2016).

However, despite the evidence that manufacturing firms in many sectors are adding service activities to their offerings and pursuing a service-led competitive strategy, it seems that these businesses often do not achieve the expected growth in revenues. This phenomenon has been termed the 'service paradox' (Gebauer, Fleisch, and Friedli, 2005). Furthermore, while manufacturing firms may offer services both in response to outside forces and to gain competitive advantage, understanding of the outside factors (contingencies) that negatively impact servitization remain poorly understood (Kowalkowski, Gebauer, and Oliva, 2017).

Although the number of studies on servitization have increased in recent years, most of the research continues to be conceptual or based on case studies (Parida et al., 2014), and a little is known about the antecedents of servitization and the impact of servitization on firm performance (Baines, 2015). Furthermore, the current literature lacks the quantitative empirical research (Kowalkowski, 2017) necessary to fill the theoretical and empirical gaps; this thesis seeks to partially fill these gaps.

This research complements the existing research in two ways. First, one could argue that designing, implementing and delivering services within manufacturing firms is a straightforward task, but this simply is not so; rather, such a strategy should be carefully and thoughtfully crafted. This research will provide the understanding necessary to do so by investigating the cause–effect relationships between the factors that influence the adoption of servitization and their impact on the firm performance. The second way this research complements the existing research is by examining the internal and external factors that the firm must understand in order to deliver a successful servitization strategy.

1.2 Gaps in the Existing Research

Managers in manufacturing firms are not aware of servitization and its impact on organisational performance (Spring and Araujo, 2013). The plethora of servitization studies that investigate the relationship between servitization and organisational performance yielded contradictory results also been vague and far from conclusive (Baines et al., 2015). Furthermore, there is a general lack of empirical studies using survey technique and large sample (Eggert et al., 2011; Eggert et al., 2014; Fang et al., 2008) to validate integrative model that inspect this relationship. There also a lack of identifying the mediators and moderators that might influence such relationship.

While servitization scholars paid no attention to the fact that, there are other factors such as service culture and the organization learning capabilities that may have a big influence on servitization and firm performance. This failure to address the influences of other factors such as those external factors also add to the limitations of current literature.

Also based on the existing literature there is no doubt about the impact of contractual risk on servitization, however, a deep insight on the true nature of such risk and its classification is not presented in the current literature, which consider rich area to be explored and bridged by this research, therefore, this study intends to investigate the multi-dimensional risk construct and its impact on the servitization process and firm performance. The literature also suffered from a huge

significant gap which is to the researcher knowledge there is no validate scale that measures servitization, due to failing attempts to conceptualize and operationalise servitization concept this huge gape this research address and will be filling this gap by developing a workable definition to servitization construct and also by validating a scale that specifically measures servitization in manufacturing firms. This study also proposed the industry clock speed as moderator of the servitization- performance relationship. In which this research is trying to bridge some of the gaps of the lack of industry level factors that might influence this relationship. The importance of this study lies in its novel attempt to enhance the servitization dialog by better understanding of the nature of the relationship between servitization and organisational performance and identifying those mediators and moderator's factors in this relationship within manufacturing firms.

As mentioned above, the existing literature suffers from two main shortcomings that underscore the purpose and the motivation of the present research and provide the rationale for this thesis and its scientific relevance. Those limitations are as follows:

1. **Theoretical limitations**

a) Limited and opaque conceptualization of servitization strategies in the manufacturing sector

b) Lack of validated scales that measure servitization

c) Lack of insight into the external contingencies (external business environment) affecting servitization

d) Insufficient consideration of the interrelation between servitization strategies and firm performance

e) Lack of consensus regarding which theoretical framework to use to examine servitization

2. Empirical limitations

a) Lack of quantitative studies empirically investigating the relationship between servitization strategies and firm performance

b) Lack of statistical cause-effect analyses that take into account moderating and mediating factors that influence the implementation of servitization strategies

1.3 Problem Delineation

In order to address the shortcomings of the existing body of research on servitization, this thesis investigates the relationships between servitization strategies and firm performance, taking into account both the external environment of the firm and its internal servitization practices. As illustrated in figure 1-1, this research problem takes a "Janus-faced" view towards servitization. It also incorporates the external and the internal perspectives on servitization and their effect on firm performance.

Figure 0-1: Dimensions of the overarching research problem

1.4 Research Aim

The aim of this thesis is to investigate the antecedents of servitization within manufacturing companies and to explore the impact of servitization strategies on organisational performance.

1.5 Research Objectives

1. Conceptualize servitization and identify its key elements, drawing on a systematic review of existing conceptual, theoretical and empirical studies.

2. Identify the internal and external factors that drive servitization by examining current theoretical and empirical development in servitization, accounting for some related theories and measuring constructs.

3. Develop a novel integrative framework for the adoption and implementation of servitization and its impact on firm performance, using theoretically grounded directional hypotheses to support the proposed research model.

4. Statistically model and empirically examine the multivariate causal relationships between servitization antecedents, servitization and firm performance.

5. Identify the different forms of service-relevant capabilities that manufacturers must possess to successfully deliver services.

6. Based on empirically validated model, this study identifies implications for theory and practitioners.

1.6 Research Questions

The research activities will be informed and guided by the following research questions:

1. What is servitization and how can it be conceptualized, operationalized and measured?

2. What are the internal and external factors driving servitization in manufacturing companies?

3. What are the relationships between external industry factors, servitization, and organisational performance in the context of manufacturing firms?

4. What is the existent relationship between servitization and firm performance and how they are bounded by organisational context?

1.7 Fundamental Aspects of Research Objectives

This thesis fundamentally depends on the collection of primary and secondary data at the firm level (Van de Ven, 2007); for this reason, the research can be considered empirical inquiry. Furthermore, this research can be considered applied research, whereby the theoretical knowledge gained can help enhance managerial decision making with regard to the phenomenon under investigation. The following scientific objectives will be applied (Neuman, 1994; Burns, 2000):

- **Descriptive objective:** Describe the main concepts, constructs or elements concerning servitization, as a fundamental aspect of any scientific research.

- **Theoretical objective (explanatory):** Empirically infer the causal relationships between endogenous and exogenous variables, and the explanation of these relationships (See Chapter 3).

- **Pragmatic objective:** Develop practical solutions and provide recommendations for real problems in the field of servitization in manufacturing.

1.8 Contributions

The contribution of this research is two-fold, including a theoretical and a pragmatic contribution. The study's findings profoundly advance the current body of servitization literature. Simultaneously, the results should enhance managerial decision-making with regard to implementing servitization strategies, while also revealing some of the limitations of servitization as a strategic choice. More importantly, this thesis considers the organisational context and the interdependencies between the

internal servitization antecedents. Therefore, the findings advance the servitization dialogue and the theoretical underpinnings of servitization practices by identifying the capabilities and resources needed to successfully implement servitization, exploring the enabling role of the external environment in the internal servitization process, and elucidating the impact of servitization on firm performance.

From a practical standpoint, the results may benefit decision makers by providing a clearer prescriptive regarding the interrelationships between external and internal factors that influence the implementation of servitization activities. Finally, the most significant impact of this thesis will result from empirically modelling how servitization and its antecedents explain firm financial and market performance.

1.9 Scientific Position and Research Strategy

1.9.1 Scientific Position and Statistical Examination

This research draws on Popper's theory of scientific explanation (Popper, 1959), which asserts that science should offer both an explanation as well as a description of a particular phenomenon. Hence, the role of scientific examination is to chart and structure such explanations. The theory furthermore stresses the importance of causality as a central pillar of scientific explanation (Popper, 2005).

In this regard, the present research utilises the Deductive-Nomological Model (DN) (Hempel, 1965) to facilitate scientific explanation. According to this model, a "scientific explanation consists of two major 'constituents'": an *explanandum*, or a sentence "describing the phenomenon to be explained" and an *explanans*, or "the class of those sentences which are adduced to account for the phenomenon" (Hempel, 1965: p. 247).

This notion encapsulates two preconditions which should be met so that the explanans can successfully explain the explanandum. First "the explanandum must be a logical consequence of the explanans" and "the sentences constituting the explanans must be true" (Hempel, 1965, p. 248). This

means that the scientific explanation must be a rigorous deductive argument in which the explanandum follows as a supposition from the main principles in the explanans (the deductive part of the model). Second, the explanans must contain at least one "law of nature" nomological. It is noteworthy to mention that 'nomological' is a philosophical term of art that roughly means "lawful" (Hempel, 1965).

In this context, de Vaus (2001) argued that social science is rather probabilistic and less deterministic. Put differently, in strands of science like economics, management, biology, and psychology, generalizations of results most often fail to meet both the measures and the criteria of lawfulness. This argument can lend itself to the organisational and managerial sciences, whose foundations are mainly built upon probabilistic assumptions, hypotheses and tendencies rather than solid laws, in contrast to natural science. As a result, the present research draws upon the critical proposition made by the deductive-statistical explanation (Popper, 2003), in which proposing hypotheses is the main premise for establishing statistical "laws" by means of deduction. This means that this research can be classified as providing a probabilistic explanation for the behaviour of people and organizations (de Vaus, 2001).

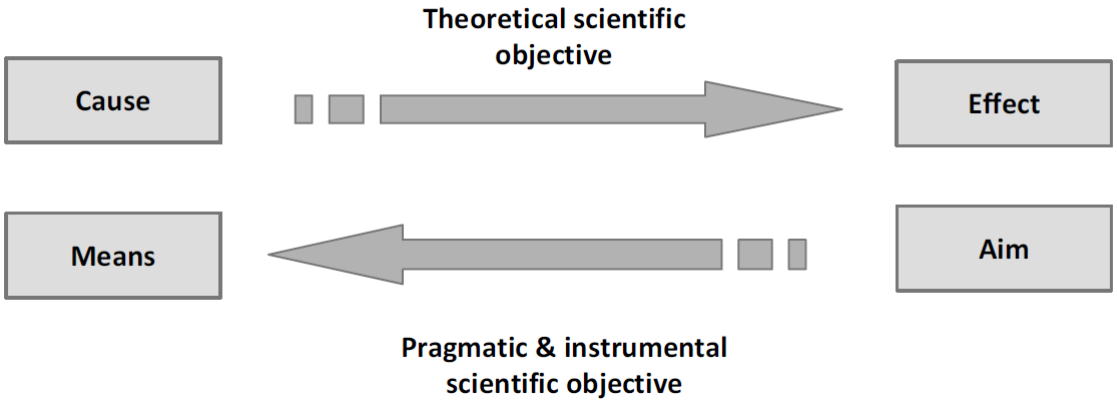

Figure 0-2: Interrelationship between theoretical and pragmatic scientific objectives (Based on: Brunswicker, 2011).

Finally, following the statistical approach to explain servitization and the probabilistic nature of causation, this research draws on Burns's (2000) suggestion that when examining cause-effect relationships, the two major pillars of scientific objectives should be followed, as shown in figure 1-2.

Elaborating on the aforementioned scientific objectives, the theoretical explanatory objective includes an empirical analysis of the causal relationship proposed by the research. Here, real, observable data is empirically analysed to yield meaningful results. The pragmatic scientific objective, on the other hand, can be claimed by means of recommendations guided by the empirical examination, which facilitates the formation of the "real" object – in case, the servitization implementation system (including servitization strategies and organisational configurations for resources and capabilities). In this context, the theoretical propositions are transformed into managerial tools and technological initiatives (Popper et al., 1973). Finally, the effect will be translated into an objective, and the cause will be applied as a means.

1.9.2 Research Design and Research Process

According to Van de Ven (2007), research design represents the structure of an enquiry. The main goal of research design is to guarantee that the research results will enable the researcher to achieve the research objectives and answer the research questions as clearly as possible. This entails identifying which strategies to implement and the method to be used to collect and analyse the data (Creswell, 2009). Furthermore, there is wide agreement among scholars that delineating causal relationships presents a significant challenge to researchers.

This challenge stems from the nature of explanatory research, which is concerned with evaluating probabilistic causal relationships. The explanatory nature of the current research involves adopting a more rigorous research process and design, as causal inference is a complex phenomenon, while other descriptive research requires a less complex design and process (Schnell et al., 1993). In this context, correlation does not necessarily equal causation. However, one of the main premises of explanatory research is to preclude any invalid inferences. This can be achieved by full consideration

to the research border context, and treating the research as an interactive process in which the research design guides the propositions regarding causality and the outcomes (Van de Ven, 2007).

In order to choose an adequate research design to answer a methodological question, three main research designs can be considered:

a) Experimental (or quasi-experimental)

b) Qualitative

c) Quantitative research

First, the experimental research design undeniably offers the most reliable results and has most powerful implications in academic discourse; it offers the means to exert control over the causal claims while ensuring internal validity (Munch and Verkuilen, 2005). However, experimental research is rarely seen in organisational studies, as it requires the conscious manipulation of independent variables and a control group against which to benchmark the results. This is difficult to achieve in complex environments such as organisations (Creswell, 2009).

The second design, qualitative research, has so far dominated the research on servitization in manufacturing firms. Data are collected through interpretive means, leading to non-generalizable results that lack accuracy and objectivity. Furthermore, this research design is inadequate for statistical explanation of causality in organizational studies and economics (Creswell, 2009).

The third type of research design, quantitative research, is considered the most adequate for testing hypotheses and examining causal models, thus facilitating the examination of the underlying relationships between interdependences and measurable variables. Therefore, the present research follows a quantitative research design to answer the research questions and accomplish the research objectives.

A cross-sectional survey instrument was used to collect data on the firm level to analyse the impact of servitization on firm performance. Structural equation modelling (SEM) was used to infer statistical causality in a complex model, ensuring accuracy and statistical rigor (Hair et al., 2013).

It is highly important to follow a set of robust steps and procedures in order to conduct quantitative empirical research (Van de Ven, 2007). Figure 1-3 illustrates the main steps followed in conducting such research. In the interest of clarity, these steps do not imply a linear process but rather a more interactive process.

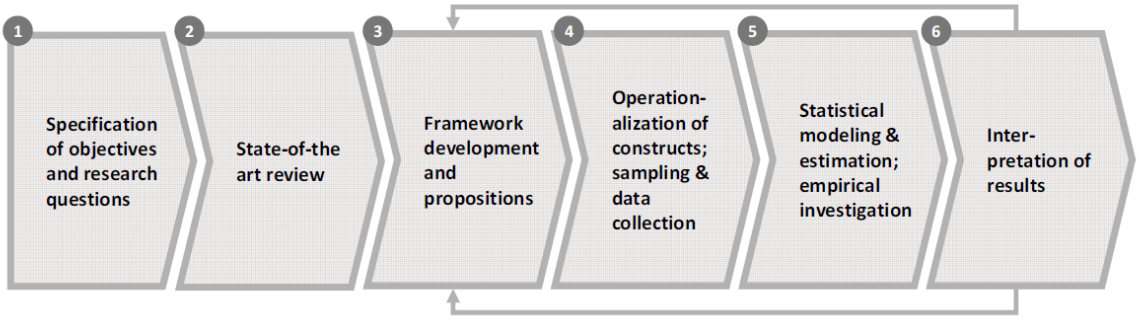

Figure 0-3: Major research activities (Based on: Brunswicker, 2011).

As figure 1-3 illustrates, the first research activity to be performed is to specify the overarching research questions. The second activity is to review the existing theoretical and empirical research on the phenomena. In carrying out this step for the present study, some of the gaps in the current literature were discovered and the important theoretical underpinnings and perspectives regarding servitization were identified.

The third activity is concerned with constructing the study's conceptual framework and developing the directional hypotheses. This framework establishes the foundation for the structural equation modelling and the empirical analysis. The fourth activity is concerned with the operationalization of the research constructs, the sampling strategy and the data collection context.

Fifth and finally, the empirical analysis is performed and the statistical estimation is carried out to infer causality. This is followed by interpretation of the results to draw out the theoretical and the pragmatic implications of the findings.

1.10 Terminology and Fundamental Concepts

This section presents some of the fundamental concepts and terms used in the research. The terms sometimes entail differences in meaning between the literature and real industrial practice. This section will therefore describe how the terms are used and understood in this research. It should be noted that servitization concept will be discussed compressively in section 2.2.5.

- **Customer**

Customer in this research refers to any economic entity who pays for the products/services or who uses or receives the product /service, unless otherwise specified. This term is synonymous with user, buyer, purchaser, consumer, and client. The customer or economic entity can be business-to-business, business-to- consumer, individual, business-to-government, etc.

- **Company**

Company refers to any organization or group of people participating in actions to generate business. Companies' main business objective in this research is to serve customers and generate profits. They achieve this by providing products, services or systems (or a combination thereof). A company can be a customer of another company when it buys products or services that other company. In this research, the term is synonymous with supplier, provider, producer, firm, enterprise and organisation. If two companies are collaborating to achieve a common goal and to mutually benefit from the collaboration, they are called partners. A company can be a manufacturer, a service provider, or both.

- **Actor**

The term actor denotes to any economic entity that is involved in the business activity between a company and a customer. Both the customer and the company can be referred to as actors. However, many different actors can participate in delivering the final product/service, for instance, employees, distributors, etc. Hence, actors can be perceived as a subcategory of stakeholders, who can be defined as anybody with an interest in the business. Actors can be those who serve upstream (supply-side) and downstream (demand side) in the economic transaction. Furthermore, actors have the capacity to influence the business process. According to actor network theory (Latour, 1991), an actor can take a non-human form, including a technology, an event, or an artefact; this perspective will also be used in this research.

- **Product**

Product in this research is contrasted with 'service,' and a clear distinction is established because the terms 'product' and 'service' have been used rather casually in the literature (Spring & Araujo, 2009). Product will be restricted to goods and physical objects, unless otherwise specified. A product can refer to the output of a business process that is offered to the marketplace and leads to the transfer of ownership of the artefact.

- **Service**

For decades, the definition of service term has been debated and it comes with several connotations. Service in this research context refers to a non-physical activity system that is the diametrical opposite to a product (the artefact system). It is considered to be any activity performed by a company and offered to a customer. It may encompass an engineering meaning in terms of maintenance of products, condition monitoring, etc., or other activities such as training, consulting, designing, financing, operating, etc. This research adopts Hill's (1977) definition of service as

> a change in the condition of a person, or a good belonging to some economic entity, brought about as the result of the activity of some other economic entity, with the approval of the first person or economic entity. (p. 23)

- **System**

System in this research refers to "a construct or collection of different elements that together produce results not obtainable by the elements alone" (Maier and Rechtin, 2002, p. 78). The main goal of such a system is to meet customer needs and to ensure high quality. Any system can be a part of a larger system with elements including people, hardware, software, facilities, and policies. A system can surround the product/service in order to enable the business activities to be carried out. For instance, a system can refer to the underlying infrastructure needed to make a phone call, with the service being the provision of telecommunications.

- **Value**

Fundamentally, value is a subjective and hard-to-define term because it is relative and context dependant. However, in this research context, value is perceived from the customer perspective, as the customer judges the value of the product or service. This judgment stems from the customer's basic beliefs about what is good and desirable. This research also takes the perspective of value related to how actors in the value chain can meet the needs of another actor by providing products, services, or both.

- **Value proposition**

Value proposition refers to any output of a company to be offered to a customer in order to generate business opportunities and solve a specific customer problem. Furthermore, the value proposition can be realised when the customer receives the product, service, or combination of both.

1.11 Structure of the Thesis

This thesis is structured into six chapters. Chapter One presented an introduction to the servitization phenomenon, followed by a delineation of the study's scope, subsequent limitations, research aims and objectives, and main research questions. Furthermore, this chapter has shed light on the research strategy and the scientific position taken, while also presenting an overview of the thesis structure.

Chapter Two presents a literature review on servitization and its meaning as a phenomenon. In so doing, the chapter establishes the servitization market offering modes, followed by the theoretical underpinnings of servitization. The chapter finishes with a reconceptualization of the phenomena under investigation.

Chapter Three establishes the study's conceptual framework, articulating the main principles of framework development and causal modelling. Next, the chapter articulates each of the study's constructs through a respective theoretical framework. This is done in order to establish the underlying assumptions of the proposed conceptual framework and its corresponding conceptual rationale, which led to the development of the postulated directional hypotheses.

Chapter Four starts with a presentation of the study's philosophical standpoint in terms of the ontology of the servitization phenomenon and the epistemology of the phenomenon. Next, the chapter covers the research methodology, including empirical context, target population, and sampling strategy. The data collection instrument is described, as well as the application of the C-OAR-SE method for measurement scale development and survey administration, followed by a description of the structure equation modelling technique for data analysis.

Chapter Five presents and discusses the findings from the statistical estimation of the study's measurement and structure models, offering a full report of the empirical results related to the study's hypotheses.

Chapter Six presents the conclusions, implications and a critical discussion. The chapter starts by presenting the theoretical implications of the research findings, followed by the pragmatic implications for practitioners. Finally, the research limitations and directions for future research are discussed.

CHAPTER 2

Literature Review

2.1 Introduction

The purpose of this chapter is to articulate the theoretical underpinnings of servitization. Firstly, the main theoretical lens resource-based view (hereafter RBV) theory, will be reviewed in order to develop a framework for servitization antecedents in manufacturing firms. Secondly, typologies of servitization will be covered. Furthermore, this literature review chapter is focusing on identifying the main antecedents of servitization, which help manufacturing firms successfully transitioning into service provision. The scope of this chapter will include addressing the main theoretical framework used in the literature to identify servitization antecedents, while the current servitization literature is mainly conceptual, there tend to be low agreement on key definitions and concepts related to servitization, in which this chapter will address and critically present servitization definitions in order to derive workable servtization definition which serves this thesis achieve its objectives and achieve a better understanding of the servitization concept. More importantly this chapter will help understand how manufacturing firms can offer a servitized market offirng, and what is the relationship between the product and service(s) in the corporate offering. To do so this chapter will also carry out systematic literature review presented to create a common understanding of the phenomenon under investigation, its different dimensiones and characteristics, in order to support the thesis's conceptual model which will further advance the knowledge base.

Vandermerwe and Rada (1988) coined the concept of servitization to denote the move by manufacturing firms to enhance their offerings by introducing the provision of services; the authors defined the concept as a move in which "corporations are increasingly offering fuller market packages or bundles of customer-focussed combinations of goods, services, support, self-service, and knowledge" (p.314).

Since then, the term has caught the attention of academia, especially in recent years, becoming a mainstream research interest in disciplines like industrial marketing and service operations management (Baines and Lightfoot, 2014; Bustinza, Parry, and Vendrell-Herrero, 2011; Lindberg and Nordin, 2008; Matthyssens and Vandenbempt, 2008; Ng, Parry, Smith, Maull, and Briscoe, 2012; Raddats and Easingwood, 2010; Spring and Araujo, 2013).

Following this development, many streams of literature have tried to implicitly and explicitly investigate the main premises of servitization, finding inventive ways to describe servitization phenomena, the most notable among them being 'systems integration' (Davies, 2004), 'service infusion' (Gustafsson, Brax, and Witell, 2010; Kowalkowski, Witell, and Gustafsson, 2013), 'service addition strategy' (Matthyssens and Vandenbempt, 2010) and 'transition to services' (Fang, Palmatier, and Steenkamp, 2008; Oliva and Kallenberg, 2003; Ulaga and Loveland, 2014).

'Product-service systems' (Manzini and Vezolli, 2003), 'performance-based logistics' (Kim et al., 2007), 'servicizing' (Rothenberg, 2007), 'product-service-system (PSS)' (Tukker and Tischner, 2006), 'functional sales' (Markeset and Kumar, 2005) and even 'full-service contracts' (Stremersch et al., 2001) are other terms and concepts that have been coined and explored.

In the context of the present research, the main focus of investigation is the servitization concept and its manifestations in manufacturing firms. Therefore, since the aforementioned concepts lie outside the scope and objectives of this research, they will not be investigated here. Nevertheless,

the term “transition to service” will be used in conjunction with servitization as described by Oliva et al. (2012, p. 5):

> This transition into services implies the bundling of services with the existing product offering and that the firm has begun to consider its offer more in terms of a service offer rather than a pure product.

Thus, as Vandermerwe and Rada (1988) assert, the term does not imply the move from a pure product to pure service offering.

2.2 Theoretical Underpinnings of Servitization: A Resource-Based View of the Firm

In order to position our research in a manner that displays coherence and scientific significance, particularly in our approach to understanding firm-level success and failure when introducing servitization strategies, this research draws upon the resource-based view of the firm (RBV) (Penrose, 1959; Richardson, 1972; Chandler, 1990) as the main theoretical lens for investigating servitization. The RBV theoretical framework is well suited to examining the effect of service transition strategies (servitization) on firm performance (Palmatier et al., 2007). In particular, this research deploys the more recent incarnation of the RBV proposed by Teece et al. (1997), in which a dynamic capability or competency-based view of the firm is taken. These two terms are usually used interchangeably in the literature, and the dynamic capabilities theory (DCT) has been used to investigate servitization from the supplier perspective in many studies (Benedetti, Neely, and Swink 2015; Fang et al., 2008; Coreynen et al., 2016; Hobday et al., 2005; Alvizos, 2012).

Notwithstanding, before developing our argument, the author will try to clarify the RBV’s theoretical framework by providing a brief explanation of how this theory was introduced and how the DCT can lend itself to disciplinary introspection on the subject of servitization.

The development of the RBV was an attempt to complement industrial organization theory (Bain, 1968; Porter, 1979), which played the protagonist role in the discipline of strategic management. This role was further consolidated through its focus on the structure-conduct-performance (SCP) paradigm, which offers a causal theoretical explanation for firm performance. The main premise of industrial organization theory is that firm performance is widely determined outside the firm, especially by the external industry structure (referred to as the positional perspective) (Barney, 2007). In contrast, the RBV takes an explicitly opposing view, arguing that a sustainable competitive advantage is attained from within the firm, particularly through the use of its internal resources. This perspective was introduced in an attempt to explain the performance discrepancies between firms in the same industry. However, the RBV's main purpose was not to replace the industrial organization view, but rather to complement it (Peteraf and Barney, 2003).

Nowadays, the RBV has gained unprecedented prominence in the organisational literature, especially in the strategy field, due to its flexibility and usefulness when working with heterogeneous firm resources. In this context RBV is defined by Rothärmel (2013, p.5) as:

> a model that sees resources as key to superior firm performance. If a resource exhibits VRIN attributes, the resource enables the firm to gain and sustain competitive advantage.

In the evolution process of this theory, two school of thought have emerged. The first is called the static RBV (Newbert, 2007), building on the work of Barney (1991), who introduced the initial value, rareness, inimitability and non-substitutability (VRIN) framework to assess the firm's resources. This stream of literature is primarily concerned with the perspective of resource efficiency, articulating the relationship between the resource's rareness and value to further explain the diverse impact it has on bottom-line performance (Peteraf and Barney, 2003).

According to Teece et al. (1994, P. 513),

> The resource-based approach sees firms with superior systems and structures being profitable not because they engage in strategic investments that may deter entry and raise prices above long run costs, but because they have markedly lower costs, or offer markedly higher quality

> or product performance. This approach focuses on the rents accruing to the owners of scarce firm-specific resources rather than the economic profits from product market positioning. Competitive advantage lies 'upstream' of product markets and rests on the firm's idiosyncratic and difficult-to imitate resources.

The RBV also stresses the strategic role that managers play in developing new capabilities (Wernerfelt, 1984). Furthermore, the RBV widely advocates the importance of both vertical integration and diversification, as both can capture and yield a good return on the firm's capital and scarce assets controlled by the firm (Wiklund and Shepherd, 2005).

The advent of information technologies and the evolution of a sophisticated breed of manufacturing firms required an expanded paradigm to understand how competitive advantage is achieved. This paved the way for the second school of thought regarding the RBV that takes a dynamic resource-based view of the firm (Armstrong and Shimizu, 2007); it is widely known in the academic arena as the Dynamic Capabilities Theory (DCT) (Teece et al., 1994) and is considered an important extension of the RBV theory (Wiklund et al., 2009).

Teece et al. (1997) define dynamic capabilities as

> the firm's processes that use resources—specifically the processes to integrate, reconfigure, gain and release resources—to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die.

In order to gain better insight into the DCT, some acceptable definitions needed to be established within the current theory. These definitions are as follows:

- **Resources**

Resources are defined as the firm-specific assets that are difficult to replicate or imitate. These include the firm's tacit knowledge, facilities, human capital, and engineering experience. These are considered hard to transfer due to transaction costs and transfer costs (Teece et al., 1994).

- **Core Competencies**

Core competencies are defined as those capabilities (know-how) that define a firm's fundamental business. For instance, IBM's core competencies might be considered to be integrated data processing and service. In other words, core competencies refer to the firm's major value-creating skills and capabilities that are distinctive.

Because the terminology of capabilities and competencies are slightly vague and show some ambiguity, it is important to reach a consensus about the real meanings of the terms. In this regard, O'Reilly and Tushman (2004) stress that capabilities are usually considered to be an outcome of managerial actions, practices or routines taken to ensure integration, learning and reconfiguration, to capture business opportunities, and to adapt as the market and technology evolve.

The DCT argues that the competitive advantage (and hence, the capabilities and competencies) of firms depend mainly on three pillars: the organizational processes, the asset position, and the paths available to that position.

The first pillar of competitive advantage, the 'organizational processes,' denote the underlying firm routines, practice patterns and learning, or simply the way of doing things in the firm, or in other words, the intra-firm configuration of resources that facilitate value creation (Barreto, 2010). To sum up the notion of process, there exist three dimensions of intra-firm processes that define the firm capabilities: first, the rather static concept represented by 'coordination and integration,' also referred to as strategic coordination; second, the transformational concept underpinning 'reconfiguration,' also referred to as operative coordination; and finally, the dynamic concept of the 'learning' process and culture (Teece et al., 1997).

The second pillar of competitive advantage, 'position,' refers to the firm's latest developments in terms of its customer base, its external relations with its network of suppliers, its complementary assets, and its in-house technology or intellectual property. The third pillar of competitive advantage,

'path,' refers in particular to 'path dependencies,' which means that the future direction or trajectory of the firm is a function of its current position. In other words, the previous path of the firm shapes its future path in a changing market.

The DCT hails the strategic necessity of building dynamic capabilities, as demonstrated by the firm's ability to build, integrate, and reconfigure capabilities to address rapid environmental changes. Adding to that, dynamic capabilities are often considered to be distinctive and idiosyncratic processes that reflect the firm's past doings and its path-dependence. This means that dynamic capabilities are highly dependent on market dynamism and resource leveraging (Teece et al., 1997; Eisenhardt and Martin, 2000). Eisenhardt and Martin (2000) advanced the RBV framework by emphasizing that competitive advantage "lies in using dynamic capabilities sooner, more astutely, or more fortuitously than the competition to create resource configurations that have that advantage" (p. 1117).

Previous research has already hinted at the link between servitization pathways and dynamic capabilities (Hobday et al., 2005; Fischer et al., 2010; Den Hertog et al., 2010; Gebauer, 2011; Gebauer et al., 2012a; Kindström et al., 2013). For instance, servitization research has investigated the optimal configuration of endogenous and exogenous resources needed to deliver a servitized offer to customers via improving the provider's dynamic capabilities (Coreynen, 2017).

Drawing on dynamic capabilities and more broadly the RBV, the present study argues that the success of servitization in achieving a competitive advantage depends on the firm's ability to adapt, integrate, and reconfigure its skills, resources, and functional competencies in a dynamic environment. Therefore, manufacturing firms that are making the strategic choice to move downstream towards servicing the final customer more directly must configuration their internal resources correctly to deliver capabilities to the end user.

Furthermore, the study's author argue that the firm's capabilities are path-dependent and indistinguishably linked to the strategic choice taken by management to outsource some operations,

develop them in house, or more actively look for collaborations with other network actors to leverage value co-creation (Hobday et al., 2005). Consequently, following Fang et al. (2008), the author argues that dynamic capabilities or "the firm's ability to integrate, build, and reconfigure internal and external competencies," are the most critical drivers of manufacturer competitive advantage and lead to higher performance.

In addition, the DCT stresses the learning process as a profound driver of innovation; the author argue that this is critical for manufacturers to implement in the process of accumulating the capabilities needed to deliver a servitized market offering, which requires continuous assimilation, transformation, and exploitation of organizational processes, while considering the environmental conditions (Fang et al., 2008; Zahra and George, 2002).

As the main objective of this research is to investigate the impact of a servitization strategy on manufacturer performance, the author argue that the service transition is widely driven by the internal innovation of the organization's processes and routines, which in turn influences the resource configuration needed to achieve the intended outcome (Winter, 2006). This means that the innovation of the firm does not lie in its ability to produce a more innovative product or service, but in the integration of routines and organisational processes to facilitate the right configuration of internal capabilities, such that an innovative servitized offer is produced in ever-changing market conditions (Birchall and Tovstiga, 2005).

Finally, the author argues that for manufacturers to successfully accomplish servitization, these very processes and organizational practices are the main antecedents of the pathway to designing, implementing, and delivering the servitized offering (Raddats and Easingwood, 2010). A detailed explanation of this argument will be developed in Chapter 3.

2.3 Internal Factors Influencing Servitization Strategies

2.3.1 Theoretical Grounding of the Conceptualization

In order to theoretically ground a robust conceptual framework for the antecedents of servitization, this research draws on the most important theoretical frameworks in order to develop proposition statements about causal relationships. The following conceptualization draws upon the following five theoretical perspectives, which inform the theoretical grounding of the research hypotheses (see figure 2-1): the resource/capability-based view of the firm (Teece, 1997), the attention-based view of the firm (Ocasio 1997), social network theory (Katz and Kahn, 1978), transaction cost economics (Williamson, 1985), and principle agent theory (Eisenhardt, 1989). These perspectives are presented in brief in the following sections.

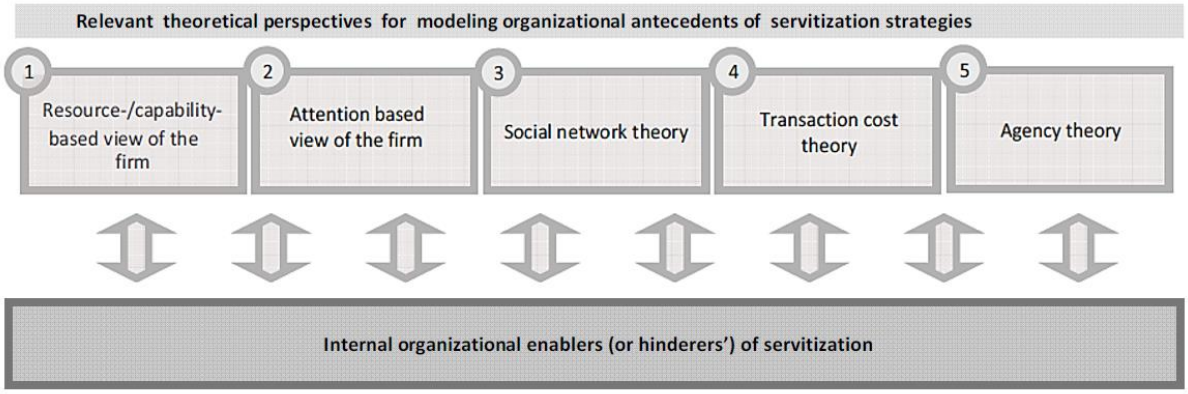

Figure 0-1: Relevant theoretical perspectives for modelling causal relationships

2.3.1.1 The Resource-based/Capability-based View of the Firm

As discussed in Chapter 2, the RBV is an influential theoretical framework that highlights the uniqueness of the firm's internal resources. It argues that the internal resources of a company are the most pivotal source of sustainable competitive advantage, which will materialise in the form of higher organizational performance over time (Barney, 1991; Penrose, 1959; Brown and Eisenhardt, 1995). Such heterogeneously distributed resources can be bundled together to achieve a competitive advantage by introducing fresh, value-creating strategies that cannot be easily replicated by rivals (Eisenhardt and Martin, 2000; Barney, 1991). In an effort to expand the static perspective of the RBV, both the capability/competency-based view and the knowledge-based view of the firm were introduced to emphasise the importance of assets that are implicit and intangible in nature and which form the source of competitive advantage (Grant, 1996a). The knowledge-based view suggests that knowledge constitutes a key resource in organizations, and that the main goal of organizations is to facilitate the creation, integration and transfer of knowledge (Grant, 1996a). While the RBV approach views competitive advantage as being achieved through the possession and exploitation of unique resources, the knowledge-based approach stresses the importance of learning and organizational renewal in achieving positive organizational performance (Grant, 1996a; Birchall and Tovstiga, 2005). A corollary to the notion of organizational knowledge-seeking is the dynamic capabilities perspective. More specifically, the knowledge creation process is widely considered to be a crucial dynamic capability, especially within high-technology firms (Teece et al., 1997). This can explain the rationale behind implementing processes to enhance the firm's absorptive capacity and external knowledge seeking.

The dynamic capability theory (DCT) is another essential extension of the RBV theory (Eisenhardt and Martin, 2000; Wiklund et al., 2009). According to Eisenhardt and Martin (2000, p. 1107),

> Dynamic capabilities are the antecedent organizational and strategic routines by which managers alter their resource base—acquire and shed resources, integrate them together, and recombine them—to generate new value-creating strategies.

In other words, dynamic capabilities can be viewed as higher-level capabilities that facilitate strategic renewal, learning and innovation the organization. Despite the idiosyncratic nature of dynamic capabilities (Teece et al., 1997), they can be very useful for understanding how managers configure internal resources to enhance the firm's absorptive capacity and value co-creation.

Teece (2007) argues that companies can achieve competitive advantage by making supernormal profits in economic terms. This can be done by fostering, protecting and managing the company's intangible assets to increase their relevance in the current service economy. In the same vein, the author argues that servitization is mostly about fostering and managing the company's intangible assets and enhancing its dynamic capabilities.

Previous research has already hinted at a link between servitization pathways and dynamic capabilities (den Hertog, van der Aa, and de Jong, 2010; Fischer et al., 2010; Gebauer, Gustafsson, and Witell, 2011; Gebauer, Paiola, and Edvardsson, 2012; Hobday et al., 2005). In particular, servitization has been investigated to understand the optimal configuration of endogenous and exogenous resources to improve the provider's dynamic capabilities so that a servitized offer can be delivered (Coreynen, Matthyssens, and Van Bockhaven, 2017; Kanninen et al., 2017)

Drawing on dynamic capabilities and, more broadly, the RBV (Barney, 1991; Wernerfelt, 1984), this research argues that the success of servitization in terms of achieving competitive advantage depends on the firm's ability to adapt, integrate, and reconfigure its skills, resources, and functional competencies within a dynamic environment. Therefore, manufacturing firms that are making the strategic decision to move downstream into servicing the final customer more directly must adjust their internal resources to achieve a configuration that can deliver capabilities to the end user (Baines and Lightfoot, 2014).

Furthermore, firm capabilities can be considered as path-dependent and indistinguishably linked to the strategic choices made by management to outsource certain operations, develop them in house, or more actively seek collaboration with other network actors. In fact, Fang et al. (2008) argue that dynamic capabilities, or the firm's ability to integrate, build, and reconfigure internal and external competencies, are the most critical antecedents of a manufacturer's competitive advantage and lead to higher performance.

DCT also stresses the learning process as a profound driver of innovation. Learning is itself a cornerstone for accumulating the capabilities necessary to deliver a servitized market offering, and it requires continuous assimilation, transformation and exploitation of external knowledge in organizational processes, while adhering to environmental conditions (Fang et al., 2008; Zahra & George, 2002).

As stated above, there are three types of dynamic capabilities – sensing, seizing and transforming – that can be used as a framework for investigating the servitization process.

- **Sensing capabilities**

In a servitized context, sensing capabilities refer to the tendency of some manufacturers to have a proactive market orientation (Voola and O'Cass, 2010) through their ability to gather relevant business intelligence locally, globally, and within the ecosystem as a whole, particularly about customers, in turn feeding the development of service provision (Kindstrom and Kowalkowski, 2009). Such sensing capabilities can be capitalized on only after the co-creation of the service in the customer's unique context (Vargo and Lusch, 2008). Furthermore, sensing capabilities can come in form of processes that facilitate collaboration as well as platforms that allow engagement with other economic entities in the ecosystem.

- **Seizing capabilities**

Seizing capabilities are concerned with the ability of management to exploit a sensed opportunity; this involves selecting the product architecture and business model, determining the enterprise boundaries, defining decision-making protocols, and building loyalty and commitment. In a servitized context, seizing capabilities are manifest in the migration from a product-centric business model to a more service-oriented business model through the leveraging of the manufacturer's service-oriented capabilities (Kowalkowski et al., 2017). Examples of seizing capabilities can be the introduction of new processes for the acquisition of external R&D, external information (market data utilization), and external cooperation with other parties to deliver innovative servitized offerings (Tsinopoulos, Sousa, and Yan, 2017).

- **Transforming capabilities**

Transforming capabilities are mostly concerned with enhancing the current business model and ordinary capabilities (current operational capability), also known as resource optimisation, which can be sufficient to exploit sensed market opportunities (Helfat and Peteraf, 2003).

Teece (2007) identifies four characteristics of the transforming stage: decentralized structures, effective incentive systems, co-specialization, and particular attention paid to knowledge management processes. Servitized manufacturers sometimes need to make fundamental changes to their business model to reap the benefits of the emerging opportunities presented by service provision (Kindstrom, 2010). This requires a fine tuning of business priorities, capabilities and the interdependencies between them (Christensen, Bartman, and Van Bever, 2016), bearing in mind that such interdependencies become rigid over time. Therefore, introducing service provision into the business model can enhance business efficiency by bringing in a new value proposition (Visnjic, Wiengarten, and Neely, 2016). In this context, a manufacturing firm's current production and operational processes might be considered as ordinary capabilities, or, as Winter (2003) suggests,

'zero-level' capabilities, which denote 'how firms earn a living now.' However, what constitutes a dynamic capability for a servitized manufacturing firm might take the form of a high-level 'transitioning' capability such as a new system for service infusion or a new production system (Spring and Araujo, 2013).

2.3.1.2 Social Network Theory and Internal Knowledge Transformation Processes

By utilising network theory in this research, the concept of social capital and the value of connections can shed light on how organizational knowledge management systems can influence the transition to service provision in manufacturing and how this affects the firm's value co-creation and performance (Brown and Duguid, 1998, 2006; Uzzi, 1997).

One of the main premises of social network theory is two-fold. First, social integration is paramount in structuring connectedness and shared meaning. Therefore, the integration mechanism facilitates external knowledge absorption, which encapsulates the process of knowledge transformation and assimilation (Todorova and Durisin, 2007). Second, the intra-organizational relationships, whether strong or weak, can also influence the firm's performance (Granovetter, 2005). The performance benefits of embedded ties are often associated with strong and more exclusive business relationships (Uzzi, 1997). Because strong ties can enhance the firm's absorptive capacity and open innovation practices (Todorova and Durisin, 2007), this research postulates them to be main antecedents of servitization in manufacturing firms.

It noteworthy to mention that social network theory contrasts transaction cost economics (TCE) theory, with the former stressing that firms may opt to build informal ties with other actors in the business ecology while the latter emphasises formal business relationships built on governance and contractual agreements. For instance, those actors can be highly specialized research communities or external relationships formed over the course of collaboration projects with other economic entities in the ecosystem (Simard and West, 2006).

2.3.1.3 Attention-Based View

According to the attention-based view of the firm (Ocasio, 1997), organizations' strategy depends on the structuring of organizational attention, and firm behaviour is the outcome of how firms channel and distribute the attention of their decision makers (Carlsson, 2008).

Ocasio (1997) argues that "an attention-based theory views the firm as systems of structurally distributed attention in which the cognition and action of individuals are not predictable from the knowledge of individuals, but derive from the specific organizational context and situations in which individual decision makers find themselves" (p. 189). From the managerial and upper echelon perspective, the dominant argument is that the information-processing capabilities of senior managers and the upper echelon exert a substantial influence on organizational practices, including strategic decisions, and the shared cognation of organizational members (Schein, 1985; Clapham and Schwenk, 1991). The attention-based view of the firm is founded on three interrelated theoretical premises: (a) focus of attention, (b) situated attention, and (c) structural distribution of attention.

The focus-of-attention principle suggests that what a decision-maker does inside the firm depends on what issues and answers the decision-maker is focusing; he or she will be selective in terms of the issues and answers attended to at any one time. The situated attention principle suggests that what issues and answers a decision-maker focuses on, and his or her response to contingences, depend on the specific context and situation. The structural-distribution-of-attention principle suggests that the specific context that decision-makers find themselves in, and how they deal with it, depend on how the firm distributes and controls the allocation of issues, answers, and decision-makers within specific firm activities, communications and procedures (Ocasio, 1997). All three principles are based on cognitive processes such as cognitive diversity, comprehensiveness, and extensiveness, reflecting the mental models of managers (Miller et al., 1998; Cho and Hambrick, 2006).

This theory can be used to analyse how a service orientation of can be embedded into organizational culture and shaped by top management to increase the manufacturing firm's service offerings (Gebauer et al., 2009).

2.3.1.4 Transaction Cost Economics (TCE)

Transaction costs economics (Williamson, 1985) argues that the optimal form of organization is primarily a function of the characteristics underlying a given exchange (Leiblein and Miller, 2003). This theory's main premises are as follows. First, economic actors are both boundedly rationale and potentially opportunistic. Second, transaction cost theory explains how unfavourable exchange conditions can increase the cost of writing enforceable contracts and create ex-post maladaptation and encapsulation problems (Williamson, 1985). Furthermore, this theory's main contribution is that it solves the management dilemma of whether to vertically integrate or disintegrate, since it argues that integration is a more efficient form of organization than market contraction, in that continuous and frequent transactions involve either highly specific assets (physical, human, or site) or high levels of uncertainty (demand or technological) (Williamson, 1975; Monteverde and Teece, 1982a). With regard to uncertainty, De vita et al. (2010) state that it refers to "the degree to which ex-ante contractual costs and ex-post monitoring and enforcing costs are augmented by environmental and behavioural unpredictability, respectively" (p.658).

The main assumptions of the TCE are human foresight, bounded rationality and opportunism (Williamson, 1999). Human foresight refers to actors who are trying to foresee consequences, and who will react to those foreseen consequences in a way that will lead to favourable outcomes. However, human foresight in turn assumes bounded rationality, in which actors try to predict the imminent consequences but are cognitively limited in doing so accurately. This notion fundamentally asserts that favourable outcomes are predicted inaccurately by human actors. A corollary of this notion is that all contractual agreements between various parties are inherently imperfect, meaning that they are unable to cover all contingencies (Alvizos, 2012). Lastly, Williamson (1999) suggests that

in some instances agents will act opportunistically in order to amplify their gains at the expense of exchange partners, regardless of the agents' initial promise. Therefore, all transactions are affected by the problem of ''self-interest seeking with guile," leading to greater economic risk for the exploited party. To mitigate this, a credible commitment can be regarded as the offering of 'hostage' assets, collateral, or plenty clauses to ensure full contractual compliance. In this context, contractual hazards materialise especially when courts are incapable of validating the exchange partners' knowledge (Williamson, 1975) or guarding weak property rights (e.g. intellectual property); when non-easily-reusable assets are held up in the exchange; or when quality, health, safety and other risks are undisclosed by the parties involved in the exchange (Williamson, 2000).

This theory can be highly beneficial when analysing why manufacturers opt to servitize and to structure their transaction costs, especially in the context of outcome-based service contracts (OBCs), which revolve around the contractual agreement to deliver predefined outcomes and results (Ng et al., 2010). Furthermore, servitized manufacturers usually modify the structural and hierarchical governance of the value creation process, sometimes favouring increased integration to enable higher productivity, which in turn reduces uncertainty and transaction costs (Williamson, 2000). Therefore, the author argues that manufacturing firms that are shifting into service provision must understand the transaction costs related to service provision and contracting; this can help them form the right governance structure (Jones, Hesterly, and Borgatti, 1997). They must also increase their understanding of both the supplier and customer side to align their market offer with the customer's transaction governance and objectives, while ensuring frictionless value co-creation.

Table 2-1 summarise the main theatrical frameworks used in this thesis to ground the research conceptual framework, they are widely used theories in the management studies and more specifically in servitization literature.

Table 0-1: Main management theories used to ground the research hypotheses (Adapted from Walker et al., 2015).

Main theories	Description	Key authors	Construct
Contingency theory	The efficiency of an organization depends on the "fit" of the internal organizational structure with environmental contingencies.	Burns and Stalker (1961); Lawrence and Lorsch (1967);	Dynamism, Industry clock speed
Recourse-/capability-based view of the firm	The resource-based view suggests that organizations should focus on their strengths through their resources rather than the environmental opportunities and threats.	Barney (1991); Wernerfelt (1984)	Servitization, Value co-creation, Absorptive capacity, Industry clock speed
Attention-based view	Organizational attention and firm behaviour are the outcome of how firms channel and distribute the attention of their decision-makers.	Ocasio (1997)	Service orientation of organizational culture
Transaction cost theory	Focuses on the make-or-buy decision and the appropriateness of different governance forms in an attempt to minimize the costs of exchanging resources with the environment.	Williamson (1975, 1991)	Risk
Social network theory	Network theory considers the relationships between (social) entities in a network.	Granovetter (1992); Huatuco et al. (2013)	Open innovation, Value co-creation

2.4 External Factors Influencing Servitization Strategies

2.4.1 Theoretical Grounding of Industry Clock Speed Conceptualization

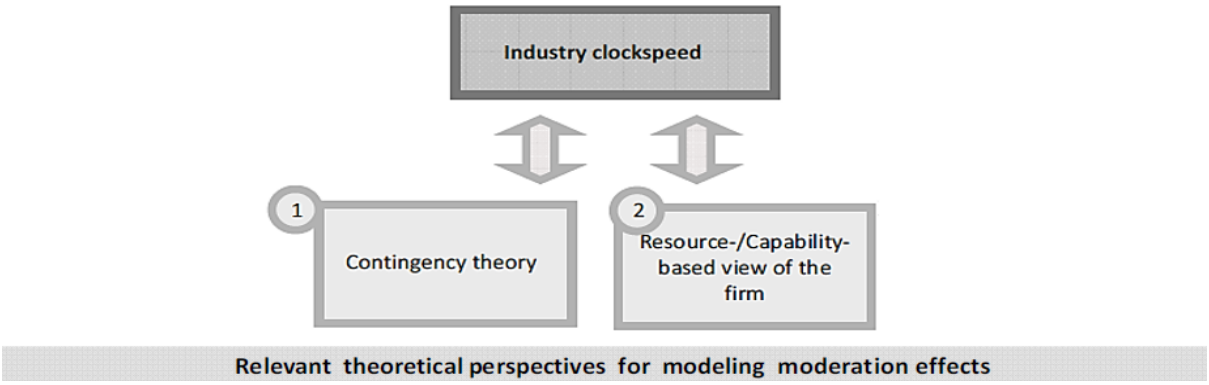

Figure 0-2: Relevant theoretical perspectives for modelling the moderation relationship

2.4.1.1 Contingency Theory

According to contingency theory, the most effective organizational structural design is one in which the structure fits the contingencies; therefore, the performance outcomes of a certain organisational response will depend on the context of the operations (Donaldson, 2001). Accordingly, contingency theory encompasses three main aspects: contingency, response and performance. Contingency variables describe the situational characteristics that are usually outside management's control, or at least involve considerable effort over a long time span (Sousa and Voss, 2008). The response aspect refers to the actions taken by the organisation in response to the contingency (Sousa and Voss, 2008). Performance aspects are the measures of effectiveness that can be used to evaluate the fit between response and contextual variables (Sousa and Voss, 2008). In this research, the deployment of this theory can help in understanding a manufacturing firm's response to contingencies, such as market volatility and industry clock speed, and can promote a more appropriate organizational design and firm effectiveness, as well as influence different parts of the organization, such as divisions, business units, functional departments, and work teams (Neu and Brown, 2005; Homburg, Workman, and Krohmer, 1999).

2.4.1.2 The Resource-based/Capability-based View of the Firm

The external factors that may influence servitization and its impact on firm performance can be analysed through a recent incarnation of the RBV, namely the dynamic capability of the firm (Teece, Pisano, and Shuen, 1997). The highly influential resource-based view of the firm suggests that firms can be conceptualized as bundles of resources that are heterogeneously distributed across the firm, where such resource differences persist over time (Eisenhardt and Martin, 2000; Wernerfelt, 1984). A key principle of this theoretical perspective is that a firm's heterogeneous resources are fundamentally idiosyncratic, emerging from the path-dependent history of the individual firm (Teece et al., 1997). Such resources are valuable, rare, inimitable, and non-substitutable (i.e., so-called VRIN attributes), and as such can be a source of competitive advantage (Eisenhardt and Martin, 2000; Wiklund et al., 2009). This research suggests a boundary condition such as industry dynamism and high velocity markets, where the strategic challenge is maintaining competitive advantage. In such market settings, managers use the firm's dynamic capabilities to adapt to external changes in the firm environment. These capabilities can take different forms. The first form is resources that can integrated, such as product development routines in manufacturing firms, by which managers combine their diverse skills and functional backgrounds to create revenue producing products and services (e.g., Clark and Fujimoto, 2005; Dougherty, 1992; Helfat and Raubitschek, 2000). The second form focuses on the reconfiguration of resources within the firm, whereby managers copy, transfer, and recombine resources, especially knowledge-based ones, within the firm. This can be achieved via resource allocation routines, which are widely used to distribute scarce resources such as capital and manufacturing assets from central points within the hierarchy (e.g., Burgelman, 1994; Burgelman et al., 2004). The third form focuses on the gain and release of resources (Eisenhardt and Martin, 2000). Such resources include knowledge creation routines by which managers and others build new forms of thinking within the firm – a particularly crucial dynamic capability in industries like pharmaceuticals, optical disks, and oil, where cutting-edge knowledge is essential for effective strategy and performance (e.g., Helfat, 1997; Henderson and Cockburn, 1994; Rosenkopf and Nerkar, 1999).

2.5 Servitization Articles

The journals with the largest numbers of contributions are presented in table 2-2. As depicted in figure 2-3, the year of publication ranged from 1988 to early 2017. A surge of interest in recent years is evident from a sharp rise in publications concerning servitization from 2009 onwards, remaining at a level of about 25 articles per year from 2012-2017.

Table 0-2: Journal distribution of servitization articles

Journal	Number of articles	Impact Factor (2016)	% of articles
Industrial Marketing Management	28	3.50	17%
Journal of Manufacturing Technology Management	19	1.75	11%
International Journal of Production Economics	18	4.34	10%
International Journal of Operations & Production Management	11	3.93	6%
Management Journal of Service Management	10	3.94	5%
Remaining 56 journals	82	N/a	51%

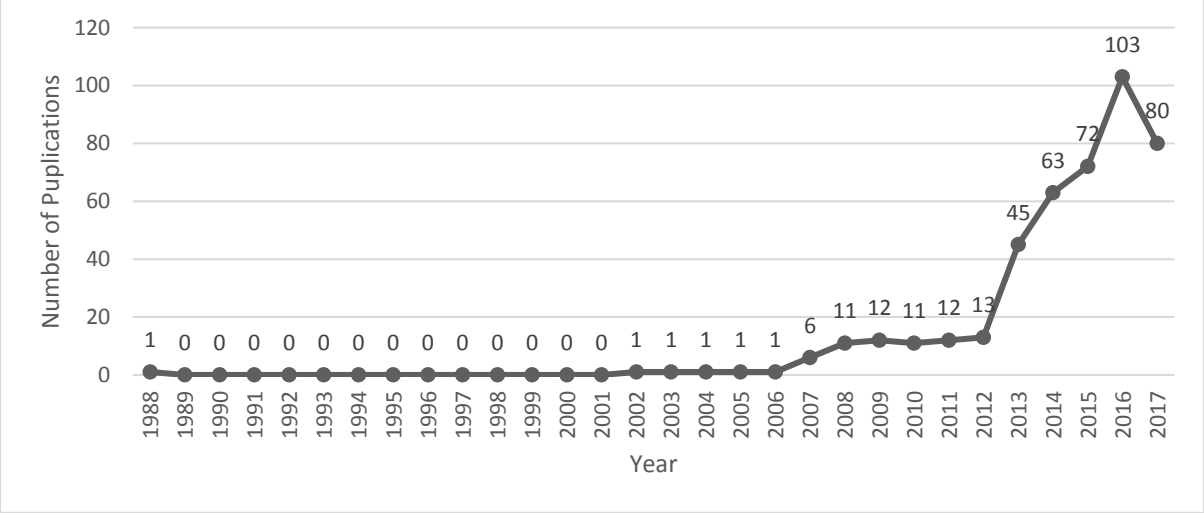

Figure 0-3: Yearly distribution of servitization articles

Table 2-3 summarizes the methodological frameworks used by the academic community in investigating servitization. The findings show that the majority of articles are primarily case studies and conceptual studies, accounting for 73% and 78% of the articles, respectively. The main aim of these studies was theory building; this has been the main focal point among servitization researchers (45% of total peer-reviewed articles), followed by theory refinement and theory exploration. It is notable that some of the research on theory refinement is not merely descriptive, but also explores and supports other theories and results. Unsurprisingly, the findings support our assertion that survey methodologies have rarely been used in the servitization research, especially for theory testing.

Table 0-3: Methodological structure of servitization research

	Action research	Case study	Conceptual study	Literature review	Quantitative	Survey/case study	Total
Description		0.7%	3%	6%	0.01%		9.7%
Exploration	0.3%	13%	5%	7%	0.2%	3%	25.5%
Theory Building	3.4%	27%	14%				44.4%
Theory refinement	0.2%	4%	3.2%	3%			10.4%
Theory testing					10%		13%
Total	3.9%	44.7%	25.2%	16%	10.2%		100%

2.6 Empirical Research on Servitization

In analysing the latest empirical studies on servitization that followed a quantitative research methodology, the systematic review yielded 16 survey-based publications. These covered only specific geographic regions, with a narrow perspective on servitization. These findings support our claim that an empirical gap exists in the servitization literature, with empirical research only accounting for approximately 10% of the total article dataset in the current review (16 out of 168 articles). Thus, quantitative analysis addressing servitization remains scant and shows limitations (Benedettini, 2015). Table 2-4 presents a list of empirical servitization research.

Table 0-4: Quantitative studies on servitization

Author	Country	Sample	Methodology	Industry
Leo and Philippe, 2001	France	8480 companies	Quantitative	Exports
Gebauer, 2007	Worldwide	30	Quantitative	Machinery and Equipment
Antioco et al., 2008	Belgium, the Netherlands and Denmark	137 companies	Quantitative	Various
Fang et al., 2008	USA	477 companies	Quantitative	Various
Gebauer, 2008	German and Switzerland	212	Quantitative	Machinery and Equipment
Neely, 2008	worldwide	13,775 companies	Quantitative	Various
Panesar et al., 2008	Norway	62 companies	Quantitative	Oil and Gas
Davidsson et al., 2009	Sweden	364 companies	Quantitative	Pulp and Paper
Gebauer et al., 2010	Europe	106	Quantitative	Various
Gebauer et al., 2011	Europe	332	Quantitative	Various
Raddats and Easingwood, 2010	UK	40	Quantitative	Various
Oliva et al., 2012	Germany	216	Quantitative	Various
Visnjic et al., 2013	Worldwide	44	Quantitative	Various
Raddats and Kowalkowski, 2014	UK	145 companies	Quantitative	Various
Eggert et al., 2014	22 countries	882 companies	Quantitative	Various
Ruizalba et al., 2016	Spain	219	Quantitative	Pharmaceutical

The most influential research on servitization using secondary data was conducted by Fang et al. (2008), who employed the COMPUSTAT database, as well as Neely (2007, 2008), who based his studies on the OSIRIS database. The information relevant to servitization in both databases comes from company profiles and should be explored with caution, using methodologies such as survey-based research (Fang et al., 2008).

2.7 Summative Content Analysis Procedures

In order to untangle some of the complexities in the servitization literature and the many concepts associated with the servitization phenomenon, a fine-grained conceptualization of the term must be developed. The first step in understanding the qualifications and meanings of the servitization concept is to undertake a rigorous structured review of the literature on the topic. Subsequently, a summative continent analysis (Hsieh and Shannon, 2005) should be done to extract and articulate a definitional view of the phenomenon. Finally, five main questions will guide the systematic review and conceptualization:

- What is the definition of servitization?
- How can a manufacturing firm perform servitization?
- What are the challenges of servitization?
- What are the main antecedents of servitization?
- How to reconceptualise servitization?

NVivo 10 software was used for the content analysis to accomplish three main objectives. First, it allowed the coding of different parameters found in the articles reviewed; second, it allowed for a detailed analysis of any emerging themes; and finally, it allowed us to structure the observations and outcomes in a meaningful manner.

This analysis constituted five major stages, each with a different focus in order to answer the review questions:

1. Stage One was concerned with determining the article's major contribution toward defining the servitization concept in manufacturing. This helped established the key definitions used in the discourse on servitization.

2. Stage Two was concerned with identifying the type of market offerings delivered by manufacturing firms when adopting a servitization strategy, along with a comparison of these offerings. This helped address the question of how manufacturing firms carry out servitization.

3. Stage Three was concerned with constructing the theoretical underpinnings of the servitization concept and determining the theoretical orientation of the current research.

4. Stage Four was concerned with identifying the emergent antecedents of and challenges faced by servitization.

5. Stage Five was concerned with reconceptualising servitization by building on robust theoretical underpinnings and insights found in the current literature.

This analysis started by highlighting the term 'servitization' in the text in order to understand the contextual use of word. This approach is referred to as manifest (on the surface) content analysis (Potter and Levine-Donnerstein, 1999), and was followed by latent (under the surface) content analysis, in which the content is interpreted (Holsti, 1969). The focus was on discovering the underlying meanings of the word and content (Babbie, 1992; Morse and Field, 1995). This approach was deemed to be adequate for this research because it is an unobtrusive and nonreactive way to study the servitization phenomenon. Huff (1990) and Duriau et al. (2007) argue that this qualitative analysis technique is powerful because the text analysis helps highlight any cognitive schemas, the aggregation of words helps unearth underlining themes, and the repetition of keywords can be used to structure associations and bonds between underling concepts.

The coding procedure was performed by the author, and acceptable inter-coder reliability was reached through a reiterative coding process (Neuendorf, 2002). It is noteworthy to mention that the content analysis was carried out as a purely qualitative approach rather than a quantitative approach entailing coefficients and thresholds. Finally, evidence for the internal consistency and credibility of the analysis are presented in Section 2.2.9 (Weber, 1990).

2.8 Definitional Issues and Contribution to Servitization Dialogue

The previous section presented the methodology for analysing the literature, and this section will present the findings with regards to definitions of servitization of manufacturing. These findings were extracted to develop a relevant conceptualisation of servitization. In order to establish a reference point for the review, the first paper that used the term, Vandermerwe and Rada (1988), will be analysed first. Subsequently, the review will take a chronological approach toward addressing the contemporary definitions of servitization in the literature.

Vandermerwe and Rada's (1988) article was primarily based on interviews with senior managers from service and manufacturing companies. The authors found that services were considered paramount in the formulation of corporate strategy and the enhancement of competitive advantage, especially for manufacturers making the strategic shift toward service provision. The most vivid argument highlighted in this thesis was that companies should always search for an adjacent service to their value proposition in order to enhance the customer experience. Furthermore, the authors suggested that an offering should be flexible and customised, and that this can be achieved by actively introducing additional products and services that extend beyond the company's core business activities.

The main contribution of this thesis is that it offers an exceedingly flexible framework that companies can follow to adopt servitization. Vandermerwe and Rada (1988) emphasise the following in particular: services can be replaced or substituted with products and products with services; services by definition can be produced by products; and services can be added to products or incorporated into the offering to improve the value proposition.

The thesis also managed to anticipate the role of technology in advancing servitization in manufacturing by addressing the role of artificial intelligence (A.I.) and expert's systems. Both of these forms of technology are now considered to be within grasp, especially with the advent of remote

monitoring systems (RMS) and diagnostic software built into smart products. Such technologies could provide machine operators and maintenance engineers with real-time information that they can then use to schedule maintenance checks, improve machine efficiency, and enhance operational efficiency (Wing, 2016).

2.9 Contemporary Definitions of Servitization

This section will address the most prominent definitions of servitization put forward in the literature, presented in a chronological manner. For full list of definitions of the concept, see table 2-5.

According to Robinson et al. (2002) servitization is

> [a concept] which goes beyond the traditional approach of providing additional services but considers the total offer to the customer as an integrated bundle consisting of both the goods and the services. (p. 150)

This definition is considered an extension of Levitt's (1969) conception of the 'augmented product' and is in line with Vandermerwe and Rada's (1988) conceptualization of the phenomenon.

Slack (2004), who comes from the operation management field states that

> servitization is the generic term that has come to mean any strategy that seeks to change the way in which product functionality is delivered to its markets. And hence companies are becoming aware of the value of the servitization of their products. That is, marketing the capability that their products bring. (p. 384)

Lewis et al. (2004) aslo adopt this definition to investigate the servitization phenomena.

Brax (2005) argues that servitization is a process in which "companies are adding more and more value to their core offering through services while experiencing a shift in their core business" (p. 146).

Ahlström and Nordin (2006) studied servitization of manufacturing in B2B business-to-business service provision context defining servitization as a strategy:

> to establish service supply relationships to deliver product services in order to augment their physical products" and thus "differentiate themselves from the competition by offering a higher level of services than their competitors. (p. 77)

Nordin (2006, p.302) further articulates the notion of "business solutions, full maintenance contracts, and managing customers' operations" as the primary strategic objectives for manufacturers, and argues that services such as "repair, product support, product-oriented training, installation, and systems integration" are secondary objectives for the servitized firm.

Lindberg and Nordin (2008) investigated the process of buying complex services (from the buyer perspective) and defined servitization as the phenomenon in which "firms move from manufacturing goods to providing services or integrating products and services into solutions or functions" (p. 292). More interestingly, this paper takes a unique approach by investigating servitization from the buyer's perspective. In doing so, the authors identify a challenger to the service-dominant logic, citing "a diametrically opposed logic implying the objectification of service … by materializing, standardizing, specifying or packaging services and making them more tangible" (p.292). For more about this strand of literature, see Araujo and Spring (2006).

In a seminal paper by Neely (2008), the financial consequences of servitization on manufacturing were investigated using a large sample of worldwide manufacturing firms. Here, the author introduced the servitization concept as a movement in which manufacturing firms "move beyond manufacturing [to] offer services and solutions, often delivered through their products, or at least in association with them" (p.104). At a further point, the paper defines servitization as "the innovation of an organisation's capabilities and processes so that it can better create mutual value through a shift from selling product[s] to selling Product–Service Systems" (p.107). It is noteworthy to mention that Baines et al. (2009a) adopted a fairly identical view of servitization. For the interest of clarity, it can be assumed that the first definition above from Neely (2008) can be viewed as a sectorial reference to the manufacturing business ecology, while the latter definition refers to the servitization of the manufacturing firm itself, in terms of the internal transformation process.

The two concepts most cited in the literature to describe the transition from manufacturing to service provision are servitization (Vandermerwe and Rada, 1988) and PSS (Goedkoop et al., 1999;

Tukker, 2004). The latter is defined as a combination of products and services in a system that provides functionality for consumers and reduces environmental impact, while servitization is defined as a market package or customer-focused combinations of goods, services, support, self-service and knowledge. As the two concepts overlap on some points, Baines et al. (2007) proposed a synthesis of both terms. A [P-S] is thus defined as an integrated combination of products and services that deliver value in use.

Later, Baines et al. (2009b, p. 495) introduced the concept of product-centric servitization, defining it as "the phenomenon where a portfolio of services is directly coupled to a product offering" or as "goods combined with closely related services (e.g. products offered with maintenance, repair, finance, etc.)."

It should be noted that Baines et al.'s (2009b) notion of product-centric implies a very specific servitization type, and thus I argue that this implies of the existence of other possible types (modes) of servitization. This will be discussed later in the chapter (Section 2.7).

According to Lewis and Howard (2009), servitization is a trend in which manufacturers place "a greater emphasis on a whole range of novel product-service combinations" (p. 3). In their paper, the authors investigated the global automotive markets from a supply chain perspective. The paper contributes to the understanding of the servitization by introducing two types of servitization strategies: 'value-creating,' meaning that it is intended to increase customer perceived value, and 'efficiency maximising,' meaning that it is intended to reduce organisational costs, which are invisible to customers. In other words, servitization can be implemented using two paths, the first of which would be leveraging the perceived value through value added to the core business offerings, and the second of which would be cost cutting via outsourcing, offloading assets and horizontal integration.

Johnstone et al. (2008) refers to servitization as "a general trend away from a 'pure product' orientation towards a combined [P-S] offering" (p. 862). This concept was utilised in the paper to

investigate servitization from an engineering, construction, and aerospace industry perspective. The authors also refer to servitization as "the increasing attention paid to developing service offerings" (p. 522). Within this school of thought, Pawar et al. (2009) define servitization as a shift in which "a transition has been recognized from an emphasis on the manufacture of products to the provision of service" (p. 469), and further as a "trend towards bundles of customer focused combinations, dominated by service" (p.474).

Schmenner (2009) draws on Vandermerwe and Rada's (1988) definition of servitization, suggesting that servitization has antecedents that have been practised for more than 150 years. Further, he refers to servitization as a term "coined to capture the innovative services that have been bundled (integrated) with goods by firms that had previously been known strictly as manufacturers" (p. 431).

In their systematic review of servitization, Brax and Visintin (2016) define the term as "a change process whereby a manufacturing company deliberately or in an emergent fashion introduces service elements in its business model." This definition takes a strategic perspective on servitization by highlighting the possibly deliberate strategy in which managers consciously follow a servitization pathway (Porter, 1985), or in which servitization strategies emerge as a response to contingences that may negatively affect firm survival (Mintzberg and Waters, 1985).

More recently Kowalkowski et al. (2017) defined servitization as "the transformational process of shifting from a product-centric business model and logic to a service-centric approach" (p. 11). Introducing the aspect of the business model change that entails the process of servitization, following this argument the author will be expanding our discussion on this issue in section 2.5.

Finally, Cenamor et al. (2017) studied servitization from a platform perspective and looked at how digitization is changing the landscape of servitization strategies. The authors conceptualize servitization as a strategy in which the manufacturing firm develops and configures a wide portfolio

of modular components of products, services, and information [technologies] to be delivered through a service platform. This elaboration emphasizes product and service modularity, which in turn facilitates the integration between different business functions. Such modularity is paramount in the coordination efforts taking place between the back end (e.g., the R & D unit) and the front end (e.g., the marketing and sales unit), representing a key aspect in the implementation of services (Silvestro and Lustrato, 2015).

2.10 Content Analysis and Findings

In examining the relevant servitization literature, a variety of contributions and definitional concepts emerged. These findings are summarized in table 2-5, along with the authors.

Following our research questions, particularly regarding what servitization involves, three main content categories were identified, one manifest and two latent. These three categories were used to inform the coding procedure. The manifest category was named 'Servitization Qualifier' (Alvizos, 2012), referring to words that were used to denote the main meaning related to servitization. Identifying these words helped answering the question 'what does servitization means?'

The two latent content categories used in the coding process were named 'Market Offering', and 'Value.' In the interest of clarity, the terms 'offer' (Johne and Storey, 1998), 'market offering' (Brännström, 2004), and 'product' (Kotler & Keller 2006) are used interchangeably to describe value propositions. The two latent categories are described as follows:

1. The 'Market Offering' latent content category refers to the type of business offering that servitized manufacturing introduce to the market. This category is mainly concerned with exploring the relationship between the product and the service(s) to reveal how the original firm offerings are presented to the marketplace. Table 2-5 presents the final codings for both the manifest category 'Servitization Qualifier' and the first latent content category 'Market Offering.'

2. The latent content category 'Value' explores how the value is created with the servitized offering. In other words, where does the value lie in a servitized offering context? The results for this category are presented in table 2-5.

2.10.1 'Servitization Qualifier' 'Market Offering' and 'Value'Categories

The coding process was informed primarily by the context in which servitization was referred to in the respective study, in terms of configuration and application. It noteworthy to mention at this point that the manifest category presents the coded content as closely as possible to the original literature source, especially in terms of the wording used by the contributing authors. This strict procedure was followed for the majority of the sample in table 2-5 to ensure the credibility of the content analysis. However, some exceptions were required for some articles (e.g., Nordin, 2006; Schmenner, 2009; Cenamor et al., 2017) in order to unearth the qualifier.

The first latent content category 'Market Offering' was used to refer to how the servitized final offering looks when introduced to the market. This categorization was inspired by Tukker (2004), who proposed that PSS offers can range from products with services as 'add-ons,' to services with tangible goods.

After the completion of coding, any possibly meaningful emergent structure was thoroughly scrutinized, resulting in the three categories described above. The first category, 'Servitization Qualifier,' entails three predominant concepts: 'Strategy,' 'Process,' and 'Trend.' Here, strategy is defined as "a plan of action designed to achieve a long-term or overall aim" (Compact Oxford English Dictionary, 2017), a trend is defined as "a general direction in which something is developing or changing," and process is defined as "a series of actions or steps taken in order to achieve a particular end".

With regard to the 'Offering' category, three overarching themes were extracted in the analysis supporting Alvizos (2012) same findings. As can be seen in Fig. 5, the first theme is called 'Product and Services,' indicating that the potential offering in a servitized context may contain two separate stages: first, selling the product by itself, and then expanding the offering by adding complementary services. Here, the manufacturer has the option to sell the newly offered service to a totally new market segment, as well as to its existing market.

The second theme within the 'Market Offering' category is 'Product with Services,' referring to the situation in which the manufacturer's servitized offering consists a core product bundled with a set of services. Conceptually, this means that the product and the service are intertwined to some degree, precluding stand-alone status for either.

The third – and most critical – theme, which emerged in the latent 'Market Offering' category, diverges significantly from the two aforementioned two themes. It is called 'Product Functionality,' denoting that the core product is a vehicle for delivering services to the customer. In other words, customers are purchasing the capabilities and functionalities of the product. At this point, it is important to clarify the meaning of 'product' in the servitization context. According to Spring and Araujo (2017), "products have been seen as largely stable entities imbued by the manufacturer with competences or 'frozen knowledge,' entering into the customer's domain to provide pre-defined 'problem solving services'" (p. 3).

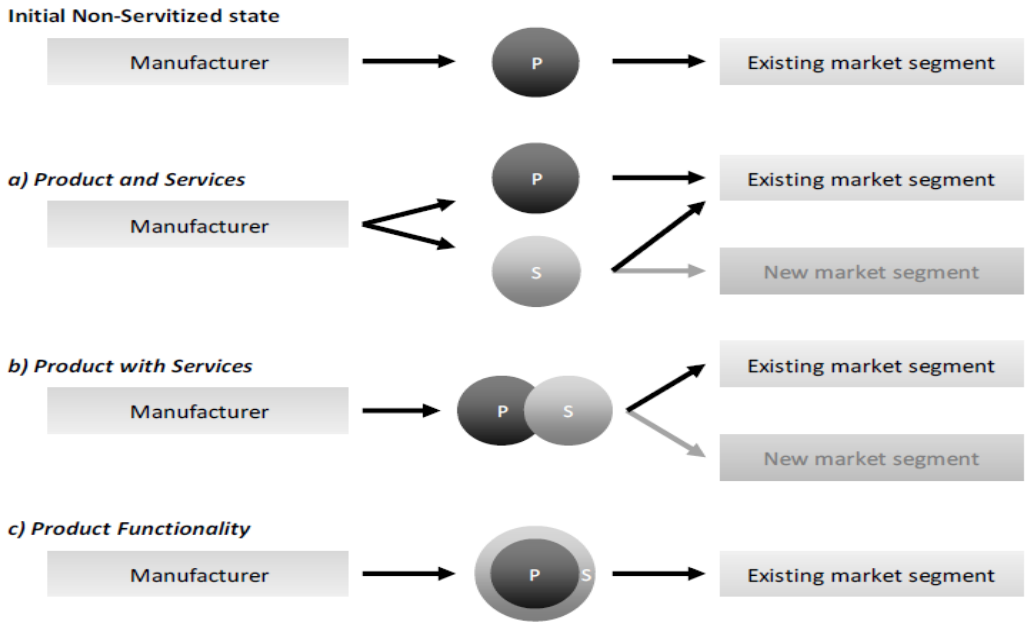

Figure 0-4: Abstract view of approaches to servitization (Source: Alvizos, 2012, p. 29).

Table 0-5: Definitions of servitization in the literature (Adopted from Alvizos, 2012)

Author(s)	Definition	Main aspects in definitions					
		Manifest content codes			Latent content codes		
		Servitization Qualifier			Market Offering		
		Strategy	Trend	Process	Product and service	Product with services	Product functionality
Robinson et al., 2002	Servitization is a concept which goes beyond providing additional services to consider the total offering to the customer as an integrated bundle consisting of both the goods and the services.		×			×	
Slack et al. 2004 Lewis et al., 2004; Slack, 2005	Servitization is a strategy that seeks to change the way in which product functionality is delivered to markets (by way of marketing the capability rather than the product).	×					×
Brax, 2005	Servitization is a process in which companies add increasing value to their core offering through services.			×	×		
Ahlström and Nordin, 2006	Servitization is a strategy that seeks to establish service supply relationships to deliver product services in order to augment a physical product offering.	×				×	
Nordin, 2006	In a servitization strategy, business solutions, full maintenance contracts, and managing customers' operations are valued over repair, product support, product-oriented training, and systems integration.	×					×
Johnson and Mena, 2008	Servitization is a competitive strategy that involves the bundling of products and services. Servitization involves a customer proposition that includes a product and a range of associated services.	×			×		
Lindberg and Nordin, 2008	Servitization is the trend in which firms move from manufacturing goods to providing services or integrating products and services into solutions or functions.		×				×
Neely, 2008	Servitization is the phenomenon in which manufacturing firms move beyond manufacturing and offer services and solutions, often delivered through their products, or at least in association with them.		×		×		
Neely, 2008; Baines et al., 2009a	Servitization is the innovation of an organisation's capabilities and processes so that it can better create mutual value through a shift from selling products to selling Product-Service Systems.			×		×	
Baines et al., 2009b	(Product-centric) servitization is the phenomenon in which a portfolio of services is directly coupled to a product offering.		×		×		

(Continuation of Table 2-6)

Author(s)	Definition	Main aspects in definitions					
		Manifest content codes			Latent content codes		
		Servitization Qualifier			Market Offering		
		Strategy	Trend	Process	Product and service	Product with services	Product functionality
Baines et al., 2009b	Servitization is the offering of goods combined with closely related services		×		×		
Lewis et al., 2008	Servitization is a strategy where manufacturers place a greater emphasis on a whole range of novel product-service combinations. Servitization may be either 'value creating' (adding perceived customer value) or 'efficiency maximizing' (a form of outsourcing).				×		×
Johnstone et al., 2008	Servitization is the general trend away from a 'pure product' orientation towards a combined Product-Service offering.		×			×	
Pawar et al., 2009	Servitization is the transition from an emphasis on the manufacture of products to the provision of services.		×		×		
Schmenner, 2009	Servitization is a term coined to capture the innovative services that have been bundled (integrated) with goods by firms that had previously been known strictly as manufacturers.			×		×	
Visnjic and Van Looy, 2013	Servitization is a business model innovation process that develops the firm's innovative capabilities and creates value at the consumer level by offering a balance of products and services.			×	×		
Baines, 2014	Servitization is a change in business model from selling products to selling capabilities, or the combination of products and services that enable the desired outcomes for customers.		×				×
Brax and Visintin, 2017	Servitization is a change process whereby a manufacturing company deliberately or in an emergent fashion introduces service elements into its business model.			×		×	
Cenamor et al., 2017	Servitization is a strategy in which a manufacturing firm develops and configures a wide portfolio of modular components of products, services and information to be delivered through a service platform.	×			×		

2.10.2 Contemporary Views of Servitization 'Market offering'

The literature content analysis highlights the concept of providing advanced services. Baines and Lightfoot (2013) define this as a focus on the capability as an outcome delivered through product use. Schroeder and Kotlarsky (2015) furthermore argue that the provision of advanced services represents a special case of servitization in which the manufacturer provides the customer with a capability instead of a product.

By investigating advanced service provision, Baines and Lightfoot (2013) offer a service typology by which manufacturers can categorize their market offerings. Figure 2-5 illustrates these three categories. The first category is labelled as 'Base Services' and refers to the core of any offering from a manufacturing firm. These are the basic services concerned with the initial provision of the product (e.g., a machine tool) and related spare parts. The second category is labelled 'Intermediate Services' and includes services such as repair and overhaul, which require a high degree of involvement from the service provider with the goal of ensuring product performance.

Finally, advanced services main features, is the economic model associated with usage and penalties. In this case, a contractual agreement is established between providers and customers to share both the risk and rewards. In addition, advanced services have been acknowledged to offer higher levels of customer value on average than intermediate services, via improved performance, availability and reliability (Baines, Lightfoot, and Smart, 2011b). Baines and Lightfoot (2013) articulate that the fundamental premise of advanced services generally requires providers to take over a customer's business process activities, and in special cases take over the customer's specific operational activity. Under this scenario, the customer pays for trouble-free operations. This is considered a backbone of the modern conceptualisation and practice of servitization.

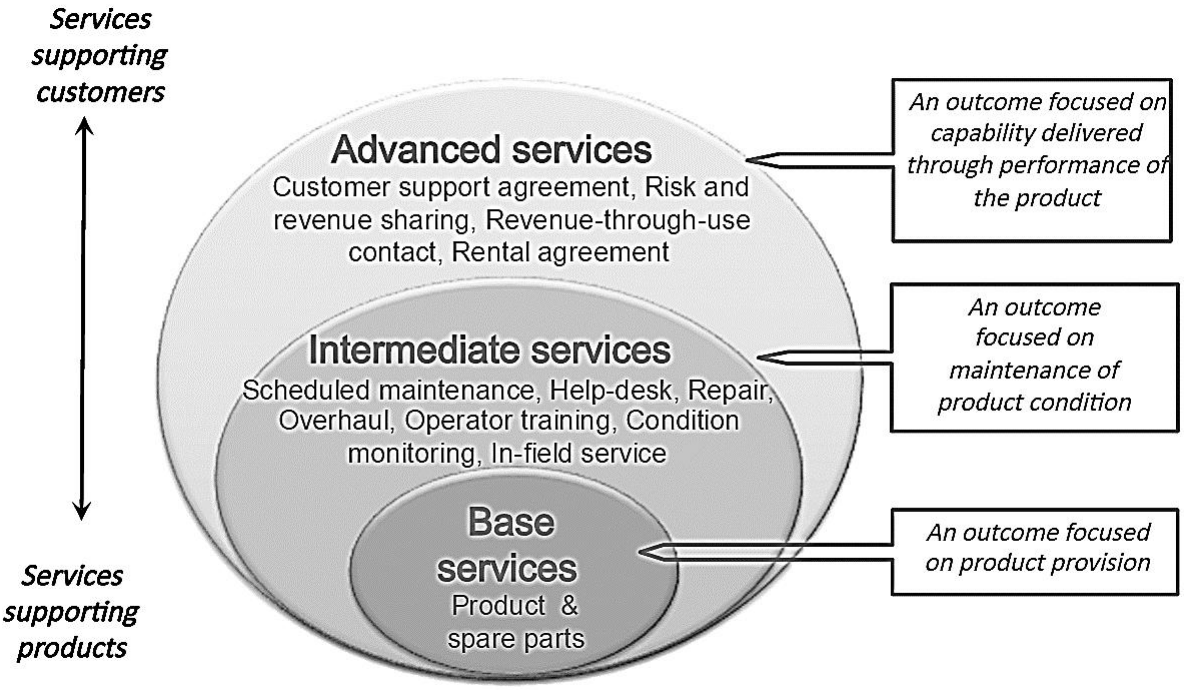

Figure 0-5: Types of services that a manufacturer can offer (Source: Baines and Lightfoot, 2013, p. 68).

Another important framework was introduced by Kindström and Kowalkowski (2014) and Ulaga and Reinartz (2011) as guidance by which manufacturing firms can excel in their service offerings; this framework is called the 'servitization pyramid.' As shown in figure 2-6, the framework has two dimensions: the horizontal dimension, in which the core focus of the service can be to support either the product or the customer processes, and the vertical dimension, which improves the value proposition on the provider side by providing customers with pre-defined input, pre-agreed-upon performance, or a guaranteed result. These market value propositions are customized to customer needs. Baines and Lightfoot (2013, p. 64) further suggest three customer segments that correspond to each type of service offering shown in figure 2-5. The first segment includes those customers "who want to do it themselves," the second are those "who want us to do it with them," and the third are those "who want us to do it for them."

Hobday et al. (2005) investigated the system integrator located at the top of the servitization pyramid; it is considered the ultimate servitization mode that a manufacturing firm can seek to acquire and provide. The authors argue that simultaneous "twin" processes of vertical integration and disintegration take place in the process of providing the solution, where the provider seeks a vertical or micro-vertical (Baines et al., 2011b) integration with the customer to provide the solution, while the customer experiences a disintegration (or from a managerial perspective, outsourcing) of some manufacturer activities in order to focus the firm on its core competencies.

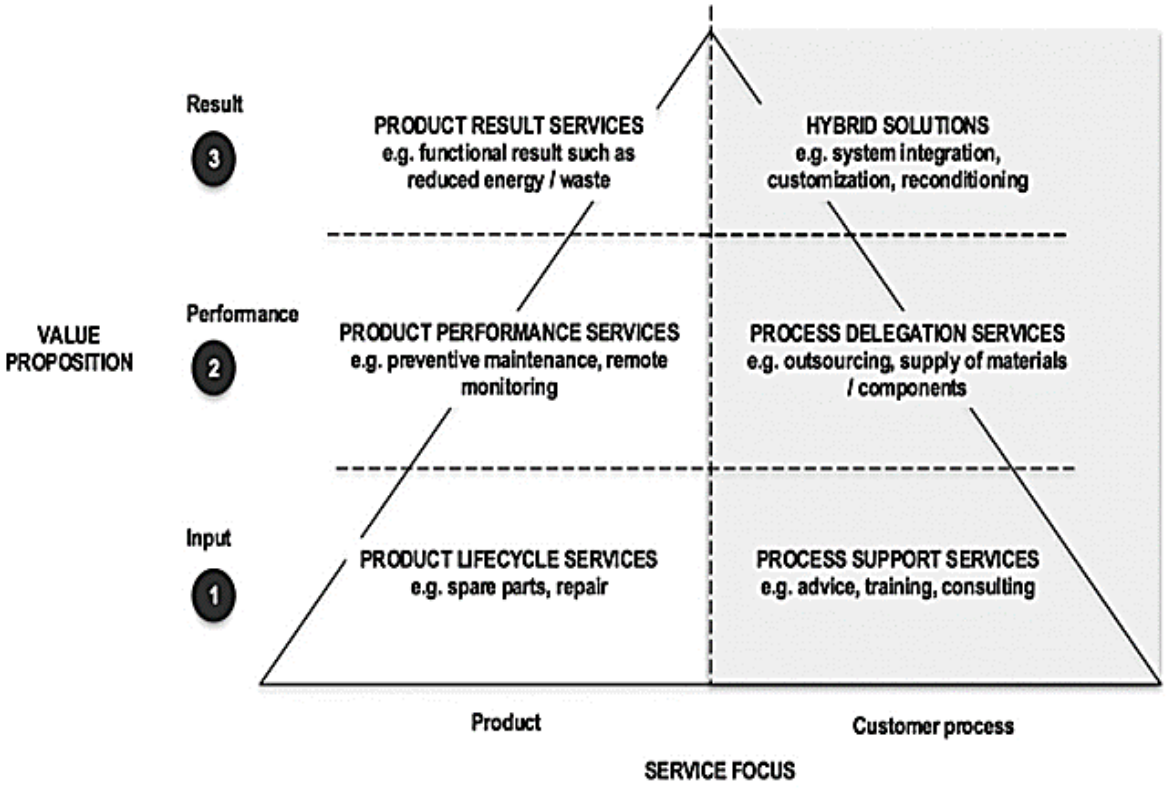

Figure 0-6: Servitization pyramid (Source: Coreynen et al., 2017, p. 2).

2.10.3 Examples of Servitization in Industry

Table 2-6 presents key examples of the shift in mindset of some leading names in global manufacturing, who uniformly march downstream in an effort to exploit opportunities provided by incorporating services.

Table 0-6: Examples of servitization in industry (Adapted from Tan, 2010)

Company	From Products Centric	To servitization and total solutions
Alstom	Railway vehicles and signalling	'Total Train-life Management' Maintenance, upgrade and operation of trains and signalling systems, product availability.
Caterpillar	Construction and mining, heavy machinery	Autonomous mining solution, financing, insurance, rental, maintenance, support, monitoring, optimization through analytics, training, etc.
Danfoss	Refrigeration controls and sensors	"Cooling total solution for food retail" – design and implementation, asset management, maintenance, energy management, etc.
Dupont	Paint	"Chemical management services" – quality painted surfaces, etc.
Douwe Egberts	Coffee	"Coffee solutions" – leasing coffee machines, supply of coffee beans, maintenance.
Electrolux	Professional washing machines	"Laundry systems" – helping initiators to start a new laundrette or to upgrade old ones, installation, training, financing, etc.
Philips	Home appliances, lighting, and medical equipment	"Pay per lux" – selling light as service, asset management, condition monitoring, etc.
Rolls Royce	Aircraft engines	"Power-by-the-hour" – Total care, guaranteed flying hours for aero engines, maintenance, back-up service, condition monitoring, predictive and self-diagnostic maintenance, spare parts life management, etc.
SKF	Ball bearings	"Engineering consultancy services" – condition monitoring, industrial sealing, lubrication and vibration analysis, etc.
Siemens	Power generation, medical technology	Energy saving; support customer operations, plant availability, asset management; equipment procurement, replacement, management, maintenance, repair and financing, etc.
Xerox	Photocopying machines	"Document management services" – guaranteed fixed price per copy, leasing, maintenance, equipment monitoring, paper and toner supply, document and data management, etc.

Industries are aspiring to transform value perceptions into value propositions in order to attract customers and lock them in. For additional insight into servitization strategies and the transition from a product-centric to a more customer-centric firm, and for examples of disruptive changes to the value proposition related to servitization and solution provision, see table 2-7.

Table 0-7: Industry examples of changes in servitization value propositions (Source: Sharma and Molloy, 1999)

Industry	Traditional Value Proposition	Solution Value Proposition
Chemicals	"We sell a wide range of lubricants."	"We can increase your machine performance and up-time."
Pharmaceuticals	"We sell pharmaceuticals."	"We help you better manage your patient base."
Utilities	"We provide electricity reliably."	"We can help you reduce your total energy costs."
Truck manufacturing	"We sell and service trucks."	"We can help you reduce your lifecycle transportation costs."

2.10.4 Servitization from the 'Value' Perspective

In this section, the second latent content category of 'Value' will be discussed. Ng and Nudurupati (2010) argue that value is clearly central to the servitization understanding, and that the current literature has diverged from the old school of thought that perceived value as coming from value-in-exchange (the transactional perspective) (Smith, 1776) to the more adequate concept of value-in-use (Vargo and Lusch, 2008).

Vargo and Lusch (2004), Tukker and Tischner, (2006) and Ng et al. (2009a) argue that value must be evaluated by the customer, rather than based on the monetary aspect during the transfer of ownership of a particular good. This shifts the firm toward a customer-focused orientated, meaning that the customer pays only for the delivered outcome, rather than simply for activities and tasks.

Furthermore, Ward and Graves (2007) argue that the mindset in manufacturing has shifted to the extent that many "now view the manufactured products as incidental" (p. 465), meaning that what is purchased is not the manufactured product but rather the benefit or "value" that is derived from the product and its associated services.

In their seminal work, Vandermerwe and Rada (1988) observe the following:

> The point … is that a larger component of the added value in customer offerings is going into services. And since the primary objective of business is to create wealth by creating value, "servitization" of business is very much a top management issue. (p. 315)

This proposition highlights the value that is added to the offer, meaning that the value is treated as cumulative as it moves downstream in the value chain (Wise and Baumgartner, 1999), and where added services are merely viewed as a differentiation strategy to achieve a competitive advantage.

Tukker (2004) articulates the value position related to PSS when he states that "the ability to create and capture sustained added value (often referred to as shareholder value) is often seen as the key measure of success in business" (p. 250). At a later point, he accepts Porter's (1985) argument that manufacturers must take a strategic position in the value network in order to capture value,

justifying his position by arguing that the creation of (tangible and intangible) value alone is not sufficient.

Neely (2008) also contributes to the debate on the servitized value argument by clarifying that his position adopts Vargo and Lusch's (2004) service dominant logic (SDL). He states that "a servitized organisation designs, builds and delivers one or more integrated product and service offerings that deliver value in use" (p. 10), meaning that the customer is only paying for the delivered outcomes, rather than for discreet activities and tasks.

Baines et al. (2009a) start their argument by viewing value as an add-on to the offering, stating that "the main part of total value creation [is] considered to stem from physical goods, and services [are] assumed purely as an add-on to products" (p. 555). The authors also maintain the service-dominant logic in perceiving value by defining PSS as an "integrated product and service offering that delivers value in use." This vague position, however, only adds to the confusion caused by the contradictory arguments from the previously-mentioned literature. Baines (2014) later takes a side favouring the SDL, stressing the notion that nowadays customers are more interested in buying a "capability" rather than products; this requires a business model change in order to deliver the sought-after value proposition.

Prahalad and Ramaswamy (2004) stress the value co-creation that occurs between the manufacturer and the customer, stating that customers nowadays are stepping out of their traditional role to become co-creators as well as consumers of value. It is important in this context to mention that the definition of value co-creation entails both value in use and value co-production, with there being a clear distinction between the two (Ranjan and Read, 2014).

According to Pawer et al. (2009), value is defined by the producer of goods and realised by the beneficiary: "This means that what is sold is not the manufactured product, but the benefit or 'value' which customers derive from the product, and associated services" (p. 469). However, their study

failed to capture the essence of value in use, implying that value is defined by the producer. This proposition is in line with the goods dominant (G-D) logic argument, in which the customer is the recipient of the goods and value is determined by the producer (Vargo and Lusch, 2004). Grönroos and Helle (2010) make a significant contribution to the value literature because in their paper,

> value for customers and value for the firm are discussed and analysed separately as separate, non-interactive phenomena. However, the value a supplier can create in a business engagement with a customer is dependant of the value that this customer can create from being involved in the same relationship. Hence … in this sense value is considered a mutually created phenomenon. (p. 565)

This manufacturing paradigm shift demands a less "firm-centric" and more interactive model of business in order to accommodate the concept of mutually created value.

Finally, Vargo and Lusch (2004 p.7) argue that in a servitized context, "a firm cannot 'satisfy' a customer; they can only collaboratively support value co creation." This means that a manufacturer's offering is purely value unrealised, i.e. a "store of potential value," until the customer releases this stored value through actual use in co-creation to realize the intended benefits (Smith et al., 2014; Ng and Smith, 2012). Table 2-8 below summarizes which types of value in a servitized offer are presented by the literature.

Table 0-8: Types of value in a servitized offer presented in the literature

Author(s)	Value Type in Servitized Offer		
	Added value	Value in use	Value co-creation
Vandermerwe and Rada, 1988	×		
Tukker, 2004	×		
Neely., 2008		×	
Baines et al., 2009; Baines et al., 2007		×	
Prahalad and Ramaswamy, 2000			×
Pawer et al., 2009		×	
Grönroos and Helle, 2010			×
Smith et al., 2014			×

2.11 Challenges of Servitization

Manufacturing firms have traditionally focused on producing products and capturing value by transferring the ownership of their product to the customer through a sales transaction (Porter and Heppelmann, 2015). Accomplishing a smooth transition from pure manufacturing to the addition of service provision is far from a seamless process (Oliva and Kallenberg, 2003), and this transition is considered to be a type of organisational change (Whelan-Berry and Somerville, 2010), requiring a deep understanding of the systematic challenges that may be faced by the manufacturer in the change process. Through the research content analysis carried out in the present study, the most prominent internal and external challenges were identified and will be described below.

2.11.1 Organisational Challenges

According to Oliva and Kallenberg (2003), manufacturing firms that undertake servitization increasingly face new realities within the firm boundaries. As such, new organisational structures need to be re-engineered to facilitate service design and delivery; new internal and external process need to be redesigned to fit the new service delivery routines; and an entire organisational alignment is needed to deliver on the new value proposition (Johansson et al., 2003).

This change process requires a fundamental change to the organizational culture, such that the organizational environment is made more accommodative to service provision. Gebauer et al. (2005) found that changing organizational culture is one of the most prominent challenges faced during servitization; this notion is widely supported in the literature (Neely, 2008; Baines et al., 2009b; Mathieu, 2001b). The fundamental change in the mindset of a manufacturer whereby the embedded product culture is abandoned is a necessity in order to become a service-centric manufacturing firm (Martinez et al., 2010; Rust and Miu, 2006). However, Slack's (2005) findings confirm that manufacturing firms widely perceive themselves to be makers of physical goods, with services being merely 'add-ons,' rather than perceiving themselves as providers of products-as-a-service; such a mindset hinders the servitization process.

Another organizational challenge facing manufacturing companies is that coherence requires awareness on the part of top management of strategic choices (Martinez et al., 2010). This challenge is manifested in the requirement to develop clear, implementable service management principles, process and recourses (Tukker and Tischner, 2006a). However, such efforts largely fail due to top management's lack of service-oriented strategic insights and skills, which are required in order to manage new, geographically dispersed activities (Araujo and Spring, 2006), as well as due to a failure to configure internal process to facilitate coordination across functional silos (Gawer and Cusumano, 2013).

Cohen et al. (2006) further argue that manufacturers need to master the art of providing solutions by 1) understanding the customers' needs, 2) building strategic partnerships, 3) managing various partners needed in the service delivery process, 4) fostering solution customization, 5) prioritizing resources, and finally, 6) planning for contingencies; all of these steps are required to put the organization on a trajectory toward servitization.

Baines (2014) and Brax and Visintin (2017) suggest that for manufacturers to successfully embrace servitization, they need to develop a new business model that can create and capture the value that servitization promises. This business model change should subsequently leverage the shift from transactional selling to a product-as-a-service model. In this context, it is the manufacturer's responsibility to support and service its products throughout the product life cycle, along with finding an innovative way to make service more tradable, with a smooth cost structure (Spring and Araujo, 2013).

Baines et al.'s (2009c) findings suggest that the process of integrating services into products will increase the organisational complexity, confirming the findings of other scholars (Johnstone et al., 2008; Tukker and Tischner, 2006a; Slack, 2005). To overcome this challenge, Gebauer et al. (2005) suggest that manufacturing firms should clearly define the service development process, which will minimize the strain on different business functions.

Furthermore, manufacturers ought to create a separate service and solution organisation that will be responsible for its own profit and losses, with its own control system, information system, and marketing and sales force. Hence, Davies et al. (2006) argue that a new firm structure must contain three fundamental functions: a front-end, customer-facing function in which the role of the salesperson is to ensure customer success; a back-end capability provider; and a strong strategic centre.

The seminal work of Reinartz and Ulaga (2008) suggests that a new breed of service managers must come into existence in order to ensure successful servitization. Such managers must have a variety of skills, talents and traits; they include service-savvy sales managers, relationship managers, and service development managers, all of whom have one goal in mind: customer success. Johnstone et al. (2009) further assert that employee engagement and commitment are critical to servitization success.

In terms of the communication challenges that manufacturing firms face in their transition to service provision, Brax (2005) found that most manufacturers have no structural process for obtaining feedback from their customers, despite the saying that 'feedback always beats a manager's intuition.' The lack of feedback and communication hinders the servitized offering. To overcome this challenge, research (e.g., Bitner and Brown, 2008; Mathieu, 2001b) has revealed that manufacturing firms must implement clear internal and external communication strategies in order to leverage cross-functional collaboration and communication within the firm's boundaries. This can lead to better customer engagement and better service customization.

In addition, some manufacturing firms that have introduced a digitization strategy are increasingly building analytics capabilities in order to understand their customers in greater detail. They are doing so by actively collecting data on the products or the processes they provide; this is called 'product wrapping' and is offered to enhance the customer experience (Westerman et al., 2014).

2.11.2 Financial Challenges

Financial challenges are considered one of the major risks and uncertainties facing manufacturing firms in their transition to service provision (Vladimirova, 2012; Oliva and Kallenberg, 2003). Changes on the firm level required in order to provide a servitized market offer involve a substantial increase in investment into acquiring new resources, capabilities and competencies (Araujo and Spring, 2006).

Despite the fact that most top management see servitization as uncharted territory as well as an opportunity that needs to be exploited (Gebauer and Fleisch, 2007), manufacturing firms still hold a fuzzy perspective on how to identify the strategic, financial, and marketing opportunities arising from service provision. In particular, they find it extremely difficult to establish the structure of their revenue model, mainly with regard to pricing their market offerings (Baines et al., 2007). This is due to top management's struggle to comprehend that pricing for services is mostly high. Thus, companies need a detailed understanding of the value stream when providing services. In addition, delivering services involves the complex integration of internal and external resources over a long period, enabling the producer to support the product over its life cycle or over its contractual agreement. This requires a special knowledge of risk management and its corresponding pricing technique (Benedettini, Swink, and Neely, 2017).

Gebauer et al. (2006) find that product managers in manufacturing firms are more risk averse than managers in different sectors, and that top management prefer an outcome of their operations that can be easily quantified. This causes them to miss out on the economic opportunities that servitization can provide. Gebauer and Friedli (2005) also found that there is a systemic bias on the part of product managers against services, as they fear the dilution of their core product strategy.

Furthermore, according to Hobday et al. (2005), most servitized companies have a serious problem with making the right choice between integration and disintegration, meaning that they widely miscalculate the transaction cost. This miscalculation leads to the strategic mistake of outsourcing core processes or vertically integrating with other actors in the network, which may cause

irreversible financial damage and hamper the firm's chances of survival if the third party fails to achieve the minimal required performance. To avoid such a situation, Neely (2008) suggests that manufactures should have a rigorous mechanism for managing and controlling long-term risk and exposure, as well as metrics to assess the financial performance of servitization.

2.11.3 Customer Challenges

The literature discussing the challenges of servitization emphasises the important role the customer plays in servitization success (Tukker and Tischner, 2006b; Vladimirova, 2012). However, customers also pose a significant challenge to manufacturing companies that are adopting servitization, in that the development of a new relationship with the customer requires cultural and cognitive proximity (Mathieu, 2001b). This challenge arises from the fundamental business model change from transaction- to relationship-based that the manufacturer must undergo, which requires a new customer-centric orientation to accommodate the new service offering (Oliva and Kallenberg, 2003; Brax, 2005).

The findings of Isaksson et al. (2009) and Baines et al. (2007) suggest that manufacturing firms adopting a servitization strategy must achieve a higher degree of customer involvement in all phases of service development, starting from the designing of the service to the actual service delivery. To overcome these customer challenges, Bitner and Brown (2008) assert that manufacturing firms should first educate their customer, second, co-create services with their customer, third, build their customer experience, fourth, know their customer's needs, and finally, enhance their customer's total experience. The servitization research also places huge importance on the value proposition, which must be focused on solving customers' actual problems and must be built on actual measurable outcomes and capabilities (Gebauer et al., 2005; Neely, 2008; Neu and Brown, 2005).

Interestingly enough, Johansson et al. (2003) suggest that manufacturing firms must servitize one customer at a time when delivering solutions, arguing that solutions have unique characteristics and require high levels of customization and integration. However, the higher the level, the more

troublesome and expensive the solution will be for the manufacture to offer it. Therefore, manufacturers adopting servitization must develop distinctive insights into their customers and industry and exploit those insights in order to develop an integrated, customized solution that outperforms the available alternatives.

Manzini and Vezzoli (2002) argue that manufacturing firms that offer services must educate their customer on the nature of the offering. This is because customers can sometimes be quite apprehensive about giving vendors access to sensitive data and specific facilities. Adding to that, customers may find it difficult to comprehend that some offerings are not based on ownership transfer, but rather on access. In this context, the customer is buying a predetermined level of availability or an outcome that meets his objectives (Matthyssens and Vandenbempt, 2010). Furthermore, some customers prefer to retain full control over their risk exposure, contradicting the main premise of servitization in terms of transferring risk to providers or at least sharing it them (Williams, 2007; Neely, 2008). Following this line of argumentation, Spring and Araujo (2009) recognize that performance-based contracts are a form of servitization, with the main focus being on "the shift in incentives and re-allocation of risk between the supplier and the customer" (p. 454). This entails the considerable challenge of defining the performance level requirement and then measuring it accordingly.

2.11.4 Supply Chain Challenges

This content analysis uncovered a wide agreement in the servitization literature with regards to the challenges faced in the supply chain, particularly in terms of managing the supplier, which requires a high level of cooperation, formation of alliances, and building of strategic partnerships, rather than a merely transactional relationship (Tukker and Tischner, 2006a; Vladimirova, 2012). In fact, the operation management discipline recommends that external resource alignment should be a strategic objective of top management in order to improve lead time (shorter time to market), market responsiveness, and achieve maximum agility (Baines et al., 2009a; Slack, 2005). Furthermore, some

manufacturers find themselves in a situation in which they are required to establish a coopetition relationship with competitor in order to achieve common goals and deliver sound solutions. For instance, rival manufacturers may share the same production platform or collaborate on a specific technology or patent (Ruizalba et al., 2016; Mathieu, 2001a).

Managing supply chain challenges in the servitization operational sphere requires a special set of skills to be formed, new partnerships to be created, and wider set of suppliers in both directions (upstream and downstream), who need to be managed effectively (Windahl and Lakemond, 2006; Johansson et al., 2003). This kind of operational development facilitates the establishment of new competitive dynamics and sometimes a shift of power occurs within the existing supply chain to accommodate the servitization initiatives (Brax, 2005; Wise and Baumgartner, 1999).

2.11.5 Market Challenges

Mont and Lindhqvist (2003) describe market challenges as circumstances imposed by the market that may adversely affect manufacturing firms adopting servitization, possibly leading to a service transition failure. Such adverse market circumstances can take the form of conflicts of interest between collaborating firms, new entrants, new public policies, new regulations, and lack of capital investment (Manzini and Vezzoli, 2002). However, Oliva and Kallenberg (2003) mention that manufacturing firms adopting servitization may

> face the difficulty of managing two tightly-coupled markets. On one hand, increasing service quality and scope might extend the product's useful life, thus reducing its replacement sales. On the other hand, increasing the quality and durability of products might reduce future service revenues. (p. 164)

In addition, firms may face great challenges in creating a service network to support a geographically dispersed installed base (IB). Finally, some scholars describe the shift from products to services as "a move into a highly complex market" (Neu and Brown, 2005), especially when the transition requires the development of new networks to work with a new distribution channel.

2.12 Antecedents of Servitization

The content analysis performed in this section reveals some of the major antecedents of servitization (Vladimirova et al., 2011b). According to Mont and Lindhqvist (2003) and Baines et al. (2009b), the antecedents, drivers, enablers or factors (these terms are used interchangeably here) of a successful transition to service provision have not received the necessary attention from the research community. Therefore, the present research will try to bridge part of this literature gap.

The current literature addresses different factors that influence the adoption of servitization strategies, such as customer pull by means of changing preferences and expectations, and technology push by means of process innovation and the advancement of information and communications technology (ICT) (Baines et al., 2009b). Some of these factors are imposed upon the firm from the immediate external environment, such as a change in the legal system that pushes the manufacturing firm to look into service provision in order to achieve compliance (Goedkoop et al., 1999). Another external factor that can push a manufacturing firm to consider a servitization strategy is the need to protect market share from competitor encroachment.

The argument put forward by Wise and Baumgartner (1999) indicates that selling standalone products is becoming less and less attractive for manufacturers, especially because the product market is currently suffering from both commoditization and stagnation. Matthyssens and Vandenbempt (2008) define commoditization as “a dynamic process that erodes the competitive differentiation potential and consequently deteriorates the financial position of any organization” (p. 317). It endangers the very existence of the firm.

Add to that the fact that products nowadays enjoy longer life spans (Wise and Baumgartner, 1999), meaning that the installed product base is expanding in an unprecedented way due to a culture of consumerism among the developed world. This product base explanation creates new opportunities for many industries to service their ever-expanding installed product base, which in turn

drives a genuine interest on the part of manufacturers to adopt servitization as a new stream of revenue (Oliva and Kallenberg, 2003).

Another important factor that leads manufacturer to seek and explore servitization pathways is the interest on the part of management in making the business more agile, flexible and highly specialized, or in other words, focusing on the business's core competences. That means that a new wave of outsourcing and disintegration is underway, which is pushing other players in the network to grab these business opportunities and vertically integrate with other customers to provide a desired solution. With this development, a new breed of firms has emerged that call themselves 'system integrators.' For example, the multinational company Apple has outsourced most of its operations to other manufacturers in order to focus on its core competencies of design, supply chain integration and marketing (Davies et al., 2007; Tukker and Tischner, 2006a).

The adoption of servitization can be seen through the lens of strategic differentiation in order to escape the product commoditisation trap and enhance the firm growth. This holds true when adding services to the firm offering as a source of competitive advantage, since services are widely considered to be more stable in an economic downturn cycle, less labour intensive, and difficult to imitate. This claim is supported by the notion that services require the building of long-term relationships with customers rather than merely transactional, short-term relationships (Goedkoop et al., 1999; Oliva and Kallenberg, 2003).

Mont (2002b) articulate that sustainability and being environmentally conscious are another major factor pushing companies to show interest in offering services, as they seek to develop the capabilities to manage products throughout their life cycle. Rabetino et al. (2015) present the typical life-cycle of a product as consisting of four phases: pre-sales, sales, post-sales and de-commissioning. The authors argue that the manufacturer's service offering can be positioned in one or more of these phases, especially in the de-commissioning phase, where the company can leverage the notion of the

circular economy. This new term refers to managing products from cradle to cradle, challenging the unidirectional management of products from cradle to grave. Spring and Araujo (2016) suggest that

> a linear 'take-make-dispose' model of production and consumption, is untenable nowadays […] as environmental pressures and material scarcity stimulate interest among industry, policy and academic communities in what is becoming known as the circular economy. (p. 2)

Other antecedents of servitization will be explored in in Chapter 3 when developing the study's conceptual framework.

2.13 Servitization and Business Model Innovation

The findings of the literature analysis show that an emerging and important new perspective on servitization has yet to materialise; this new perspective views servitization as merely a change in the manufacturer's business model to incorporate service provision and deliver capabilities (Baines, 2014; Brax and Visintin, 2017).

In order to understand this emerging theme, it is important to explore the meaning of a business model. However, as the business model literature is vast and diverse (e.g., Morris et al., 2005; Osterwalder et al., 2005; Richardson, 2008; Teece, 2010; Bask et al., 2010; Zott et al., 2011; George and Bock, 2011), a deep investigation of business model innovation is outside the scope of this research. As such, this thesis will adopt the most influential definition of a business model, developed by Harvard scholars Christensen and Johnson (2010). This framework will help to explain the servitization strategy in a more profound way and will strengthen the theoretical underpinnings of this research.

According to Christensen and Johnson (2010), the conventional business model encapsulates four intertwining – and thus, interdependent – elements, that when incorporated together, lead to the creation and delivery of value. These are the value proposition, resources, processes, and finally, the profit formula (see figure 2-7).

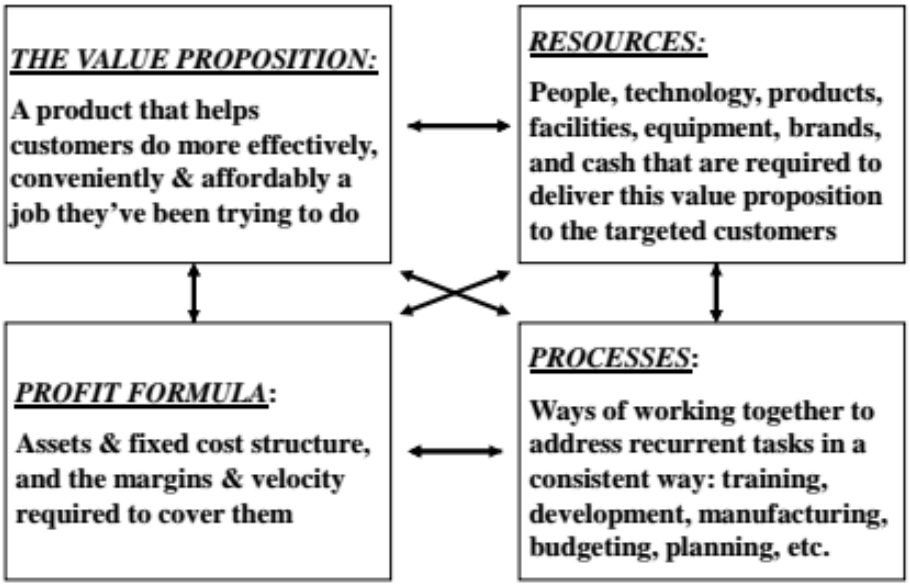

Figure 0-7: Business model elements (Source: Christensen and Johnson, 2010, p.2).

The meaning of each element in the framework depicted in figure 2-7, and how it relates to manufacturer servitization strategies, will be explained in the following.

2.13.1 Value Proposition

The value proposition refers in this context to the solution (product or service) that enables the customer to undertake a specific job they are trying to accomplish in a more efficient and affordable way. Here, job refers to a business problem the customer faces, leading to the need to seek a solution. This job is usually multidimensional, meaning that there can be functional, social, and emotional dimensions to the result that is required. In short, the value proposition asks "what is needed for the job to be done perfectly?" from the customer perspective. If the value proposition helps the customer accomplish a job they are not trying to do – even if the customer should be doing that job – it falls outside the fundamental basis for a business model.

2.13.2 Resources

A clear articulation of the value proposition is pivotal to clearly defining the resources a firm must deploy to deliver the sought-after value proposition. These resources, for instance, can be considered to be anything the firm can buy or sell, hire or fire, or assemble or dismantle, such as human capital, facilities, technology, brand, distribution channels, cash, products, etc.

2.13.3 Processes

As a firm deploys its resources to deliver the value proposition, processes glue things together (integrate). Processes in general have two segments. The first consists of the processes that can be controlled, monitored and consciously managed; these are mainly visible and can be codified. The second segment consists of routines and recurring tasks that evolve over time to form a habitual way of working together. Once these processes start to work together continuously and harmoniously in a successful manner, they become the status quo of the firm and will be followed by mere assumption rather than explicit decision. This helps create the so-called the 'culture of the organization.'

2.13.4 Profit Formula

In general, the profit formula is concerned with the question of how firms make money from their value proposition. The profit formula (or revenue model) is concerned with the key financial indicators, the gross and net margins that the firm must meet the structure of the firm, and the fixed and variable costs related to its resources. It also identifies the size of the firm needed in order to break even, the adequate level of return on assets, and profit improvement patterns.

In sum, the value proposition is concerned with how a firm creates value for customers, while the profit formula is concerned with how the firm creates value for the firm and its shareholders. The resources and processes are concerned with the mechanism by which value will be delivered to both the customer and the firm.

In a further elaboration of this business model framework, the arrows that connect the boxes in figure 2-7 are bidirectional because the sequence in which the four boxes of the business model are assembled typically varies by circumstance. For instance, when a manufacturing firm offers a value proposition in the form of service provision, such as product functionality and reliability, the sequence usually proceeds in a clockwise manner starting from the value proposition. In this context, the profit formula is derived from the resources and processes that are required to deliver the service – the product functionality and reliability. Building on the perspectives in the aforementioned business model literature, Baines (2014) argues that pure manufacturers are required to innovate and change their business model by having the right resources with the right processes and the right revenue model to successfully undertake the servitization journey. The present paper will maintain this view of servitization and will argue that servitization in one way or another requires a change in the business model of the manufacturer, or a fundamental repositioning of the business model, to incorporate services in the firm offering. This position is taken when reconceptualising servitization Section 2.7.

2.14 Reconceptualization of the Servitization Concept

In this section, I will attempt to synthesize the literature's findings as well as add a critical interpretation of the literature by reframing of servitization concept to arrive at a definition that suits the objectives of this research. The definitional analysis of servitization presented earlier in this chapter, coupled with the categorization of servitized market offerings by manufacturing firms, can be explained by the RBV theoretical framework, which in turn emphasises the 'business model change' required by manufacturers in order to move into service provision.

This thesis adopts a business model definition that is fundamentally rooted in the RBV's main premises in terms of the crucial importance of adjusting the intra- and inter-firm resources and processes to match market dynamism. The findings from the systematic literature review suggest that the market offering is the main unit of analysis that determines the following: 1) the extent to which the manufacturer needs to integrate with the customer; 2) the extent to which the firm must change its business model; 3) the extent to which risk exposure is acceptable; 4) the required degree of customer intimacy; 5) the degree of service complexity required, and 6) the degree of value co-creation required. To shed more light on these postulations, four different modes of market offerings in a servitized context are proposed:

- Product-centric servitization
- Process-centric servitization
- Operation-centric servitization
- Platform-centric servitization

Figure 2-8 depicts these four servitization modes, each of which requires a different degree of business model change and a different level of customer integration.

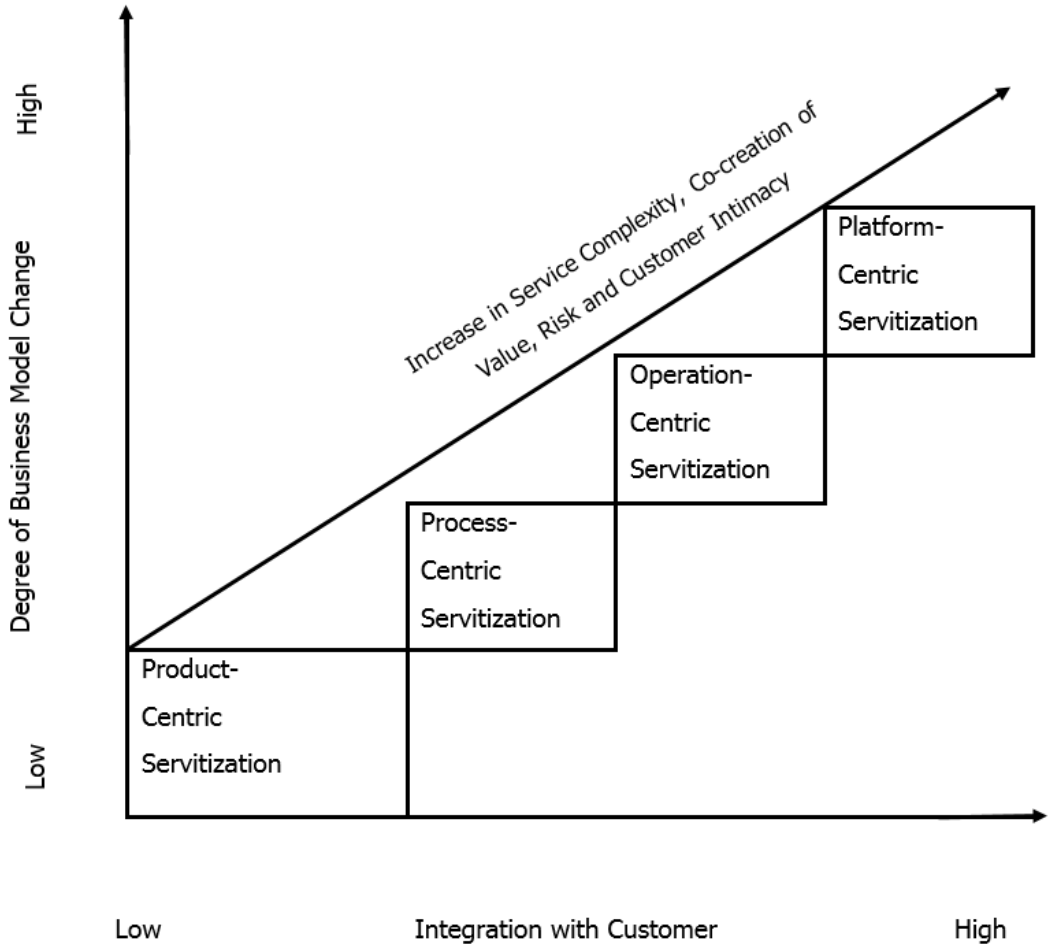

Figure 0-8: Servitization modes

2.14.1 Product-Centric Servitization

Product-centric servitization refers to the outcome focused on product provision (Baines et al., 2009a) such as providing spare parts. This mode of basic services requires a low degree of integration with customer process and necessitates no fundamental alteration in the provider's business model. It usually does not require any customer intimacy in terms of the exchange, as it is recognized to be mostly transaction based. Thus, in this context, providing services is considered to be low risk, the co-creation value is very minimal, the service design is far from complex, and value is added to the product.

2.14.2 Process-Centric Servitization

According to Kindstrom and Kowalkowski (2014), process-centric servitization refers to the outcome focused on asset management, preventive maintenance, and condition monitoring. This mode of servitization requires a higher degree of customer integration and a modest alteration of the provider's business model in terms of incorporating different resources and new process to achieve the outcome the customer is seeking. The service design requires some degree of complexity and there is higher risk exposure. The manufacturer attempts to increase customer intimacy in terms of a better relationship and collaboration in order to overcome some of the servitization challenges posed by customer or the market. A good example of this mode of servitization is the paint manufacturer DuPont, which provides services to the automobile industry. As an alternative to selling paint and being paid per litre supplied, DuPont is now involved in operating the car manufacturer paint line (taking over the painting process) and is paid per car painted. This is an explicit example of the common practice known as chemical management services (CMS) (Stoughton and Votta, 2003).

2.14.3 Operation-Centric Servitization

According to Ulaga and Reinartz (2008), operation-centric servitization refers to outcomes focused on capability delivery, in which a higher degree of integration with the customer is needed as well as a greater degree of business model modification. The main objective, from the customer perspective, is

to disintegrate from a specific operational function and outsource this entire operational activity to a third party – in many cases, to a manufacturer that has adopted a servitization strategy. This mode of servitization can be seen as the situation in which manufacturer moves from a 'box-pushing' business model to some form of an 'availability/leasing' business model, where the firm's main focus remains on the original product market segment (e.g. Rolls Royce's Power-by-the-Hour total service offering). In this context, a contractual agreement needs to be executed, governance modifications need to be introduced, and value is delivered through customer use (value-in-use). The risk is higher with this form of servitization due to the increased service complexity and responsibility. This type of outcome-based contract is usually designed to share the rewards and penalise poor performance.

2.14.4 Platform-Centric Servitization

The term 'platform-centric servitization' is being put forth by the present paper in an attempt to advance and develop the servitization literature. This term refers to manufacturing firms that deliver services through a high degree of customer integration and a high degree of business model modification, where the service offering is highly complex and the value proposition is based on a high degree of value co-creation between the different actors in the ecosystem. A good example of a platform leader is Intel, the world's leading manufacturer of microprocessors. The company created a platform aimed at orchestrating industry-level innovation by providing an open system and interfaces to enable outside companies to 'plug in' complementary products and services for solution delivery. This platform serves different business environments and different industrial sectors.

The main focus of this emerging concept of platform architecture and design is to build a base of modular products and services, which can later be integrated to deliver a customized solution to the customer. Another interesting example is Daimler AG, the holding company that manufactures the prestigious Mercedes Benz luxury car brand. This company recently views itself as provider of mobility rather than a manufacturing company, and it has built its platform around services. It outsources the manufacturing of many car parts to third parties, and has built its platform to be a

system integrator for information from different vendors (Daimler, 2016). It is important to understand that several manufacturing firms have developed 'product platforms' in which the customer solution is delivered by simply modifying, adding, or subtracting different features (Gawer and Cusumano, 2013). In this context, Baines (2009) suggests that managers should move toward 'portfolio thinking' in delivering products and services. However, the author favours Gawer and Cusumano's (2013) suggestion of "platform thinking," which refers to "understanding the common elements that tie the firm's offerings, markets, and processes together, and exploit[ing] these commonalities to create leveraged growth and variety" (p. 419).

In their interesting article, "Products to Platforms: Making the Leap," Zhu and Furr (2016) state the following:

> In a product business model, firms create value by developing differentiated products for specific customer needs, and they capture value by charging money for those items. In a platform business model, firms create value primarily by connecting users and third parties, and they capture value by charging fees for access to the platform. Platform models bring a shift in emphasis—from meeting specific customer needs to encouraging mass-market adoption in order to maximize the number of interactions, or from product-related sources of competitive advantage (such as product differentiation) to network-related sources of competitive advantage (the network effects of connecting many users and third parties).

As this research is concerned with how platform thinking can be utilized in the servitization context, it is highly important to understand the term 'external or industry platform.' This term has been defined by Gawer and Cusumano, (2013, p. 410) as follows:

> Products, services, or technologies developed by one or more firms, and which serve as foundations upon which a larger number of firms can build further complementary innovations and potentially generate network effects.

This type of platform is highly dependent on, first, the co-creation of value between network actors, second, the level of access of outside firms to the platform in order to utilize its capabilities, and finally, the degree of risk sharing among the members of the ecosystem. However, for this type of platform to succeed, it is vital to ensure the openness of the system. Such openness should be embedded in the platform foundation to foster the scalability by linking the core and peripheral subsystem

components, which collaborate to deliver a specific solution to a customer problem. This can be achieved while maintaining some degree of control over the platform and its interdependences (Schilling, 2009). Furthermore, the main premise of platform thinking is that the platform is being founded as a 'manageable object,' meaning that the organizations that embrace it are purposefully bringing together multiple actors within the industry as users and complementors.

The emerging literature on servitization has sporadically discussed the platform idea in terms of the formation of a servitization strategy. There are three major themes in such research. The first is the use of platforms for service modularization (Pekkarinen and Ulkuniemi, 2008). From the modularization perspective, the platform's main purpose is to allow manufacturers to develop, organize and provide modularized service offerings. The second theme is service delivery (Kowalkowski et al., 2013; Brax and Jonsson, 2009), and third is the creation of service innovation and provision networks (Gebauer et al., 2013; Den Hertog et al., 2010).

The notion of core capabilities has also been introduced to the platform and servitization literature, with the argument that platform capabilities are the foundation to providing solution offerings (Kowalkowski et al., 2013). Spring and Araujo (2013) adopt the inter-organisational perspective of manufacturing firms, suggesting that such firms should be seen as service platforms, and as a collection of productive opportunities and knowledge resources that are integrated within the company platform. Furthermore, the importance of sharing resources in a platform domain has been highlighted by Palo and Tähtinen (2011), whose findings confirm that platform adoption by a manufacturing firm boosts cooperation in a servitized context and yields better service performance.

In the servitization context, Brax and Jonsson (2009) and Kowalkowski et al. (2013) use the term 'platform' to refer to the integrated solution and service provided, introducing two fundamental types of platforms to be used in servitization. The first is called the operative platform, where the platform is opened to a third party so that it can get involved in the value creation. The second is called a customer-to-customer intermediary, where the platform brings together the two sides of the

market, the supply and the demand, enabling an independent transaction between the two market sides, changing the role of the manufacturing company to be service intermediary, with main role to introduce adequate governance, foster synergies, and co-specialization (Teece, 2007).

For this research, it is highly important to have a clear understanding of the circumstances and conditions in which a manufacturer is to be considered to be adopting servitization. To address this issue, the literature suggests that a manufacturer with a servitized offering should have the following characteristics:

1.12 Offers services that are clearly defined as service concepts, i.e. they can be purchased separately, like goods (Turunen and Finn, 2014).

1.13 Earns returns on services, i.e. the service business is liable for part of the total returns, which average approximately 20%–30% of total firm sales (Fang et al., 2008).

1.14 Has allocated human resources for service development and delivery (Turunen and Finn, 2014).

In summary, this chapter has presented the following findings. First, it conceptualized the four modes of servitization, which will help facilitate the contextual study of servitization. Second, the author introduced the importance of business model innovation when shifting toward service provision. Third, the author adopted a clear progressive set of criteria that must be met if any manufacturer is to be considered as adopting servitization. Fourth, following Hobday et al. (2005), the author argued that it is crucial to broaden the scope of the abstract conceptualization of servitization by further including the position of the manufacturer in the value stream. Finally, building on the RBV and its recent incarnation, the DCT, the author argued that this theoretical framework is adequate for explaining servitization and the transition to services in terms of resource configurations and fit with the market dynamics. In this context and in our quest to find and formulate a shared terminology for

the concept of servitization, this research builds on Hobday et al. (2005) and Baines (2014) to propose the following definition:

> Servitization is a strategy in which firms adapt their business models in order to gain capabilities that will enable them to move selectively up- and downstream in the marketplace through the simultaneous “twin” processes of vertical integration and disintegration.

CHAPTER 3

Hypotheses Development

3.1 Introduction

This chapter presents the theoretically grounded conceptual framework developed to measure servitization and its impact on firm performance. This thesis is proposing a model that is referred to as the servitization basic model, henceforth SBM, which integrates different theoretical frameworks. The model provides the foundation for the empirical quantitative examination conducted by means of the second-generation multivariate statistical analysis method, structural equation modelling (SEM). The research model proposes two kinds of constructs, internal and external, both of which influence servitization strategies and the impact of servitization on firm performance. All of the postulated directional hypotheses developed for this research are based on prior studies in industrial marketing, strategic management, innovation management, operations management, system design and marketing. This present study strives to achieve originality and novelty through capturing a small number of factors that can account for most of the variance in servitization's impact, thus facilitating the prediction of firm performance. First, this chapter presents the main modelling principles used to create a valid causal framework with latent variables. Second, the conceptual framework is presented, incorporating the internal and external factors that influence servitization strategies and their impact on firm performance.

3.2 Principles of Framework Development and Conceptual Modelling

3.2.1 Conceptual and Theoretical Pluralism

According to Schnell et al. (1993), a rigorous causal effects analysis requires the conceptual framework to be grounded theoretically. As shown in previous chapters, servitization has been investigated from multiple theoretical perspectives, for instance, organisational ecology theory (e.g., Turunen and Finne, 2014), contingency theory (e.g., Gebauer, 2008; Finne, 2014), RBV and dynamic capabilities (e.g., Ulaga and Reinartz, 2011; Davies, 2006; Fang et al., 2008; Benedettini et al., 2015), the theory of the growth of the firm (e.g., Spring & Araujo 2006), game theory (e.g., Lee et al., 2015), agency theory (e.g., Kim, Cohen, and Netessine, 2007), social network theory (Lindahl et al., 2014) and transaction cost theory (e.g., Viitamo, 2013; Zhong, 2014). This confirms our position that a single theoretical perspective is inadequate to model servitization and its impact on firm performance. Therefore, the present study draws on several theories and relevant concepts revealed to be pertinent when reviewing the current research (Chapter 2).

3.2.2 Contingent Modelling

As discussed in the previous chapters, the prior empirical research has fallen short in terms of capturing the complex interrelationships among servitization antecedents, servitization strategies and firm performance. In this context, contingency theory and contingent modelling provide a better lens through which to investigate the role played by third variables in influencing the relationship between servitization and firm performance (Gebauer, 2008; Finne, 2014). Contingency theory and its applications in contingent modelling stem from organizational theory (Donaldson, 2001). The main premise of contingency theory is that organizational performance depends on the adequate alignment of three sets of variables: environment, strategy and organizational design factors (Damanpour and Gopalakrishnan, 1998; Mintzberg, 1991). Therefore, the optimal organizational structure must be adjusted to fit a specific contingency, such as strategy, technology, or any emerging uncertainty.

In a focused effort, Barley (1990) and Tidd (2001) attempted to refine the methodological and theoretical bases of contingency theory, finding that contingency modelling can usually be used to understand the relationship between two variables in a two-way interaction. As such, the interaction between the organizational context and firm performance can be studied in this way (Wiklund and Shepherd, 2005).

Boal and Bryson (1987) proposed four alternative models for examining the effect of third variables as a means of exploring contingency relationships. For instance, modelling the contingencies helps in explaining the interrelationships between independent variables (IVs) such as firm servitization, and dependent variables (DVs) such as firm performance (Lumpkin and Dess, 1996). These four models include moderating, mediating, interactive, and independent effects (see figure 3-1).

First, in the moderating effect, the third variable may influence the strength of the effect of an IV on a DV (Lumpkin and Dess, 1996). In other words, in this model, the form or strength of the relationship between the independent and dependant variables varies as a function of the third moderating variable. This kind of model and relationship is widely used in social science research such as management research, economics and most widely, psychology research (Baron and Kenny, 1986).

Second, mediating factors are considered to be variables that transmit the indirect effects of an independent variable or variables on a dependent variable. In other words, a mediator can be a potential generative mechanism by which a focal independent variable can influence a dependent variable. When the effect of the mediator is removed, the relationship between the independent and dependent variables may go away (Baron and Kenny, 1986).

Third, interacting effects denote that the effect on the dependent variable occurs if and only if a set of variables are combined. Put differently, one standalone variable will not have a direct effect

on the dependent variable (Baron and Kenny, 1986). However, this type of relationship has hardly been seen in strategy and industrial marketing research.

Fourth and finally, independent factors are considered to be variables that have a direct effect on a dependant variable, which may explain some of the variance of the independent factor and have an effect size on the dependent variable (Lumpkin and Dess, 1996).

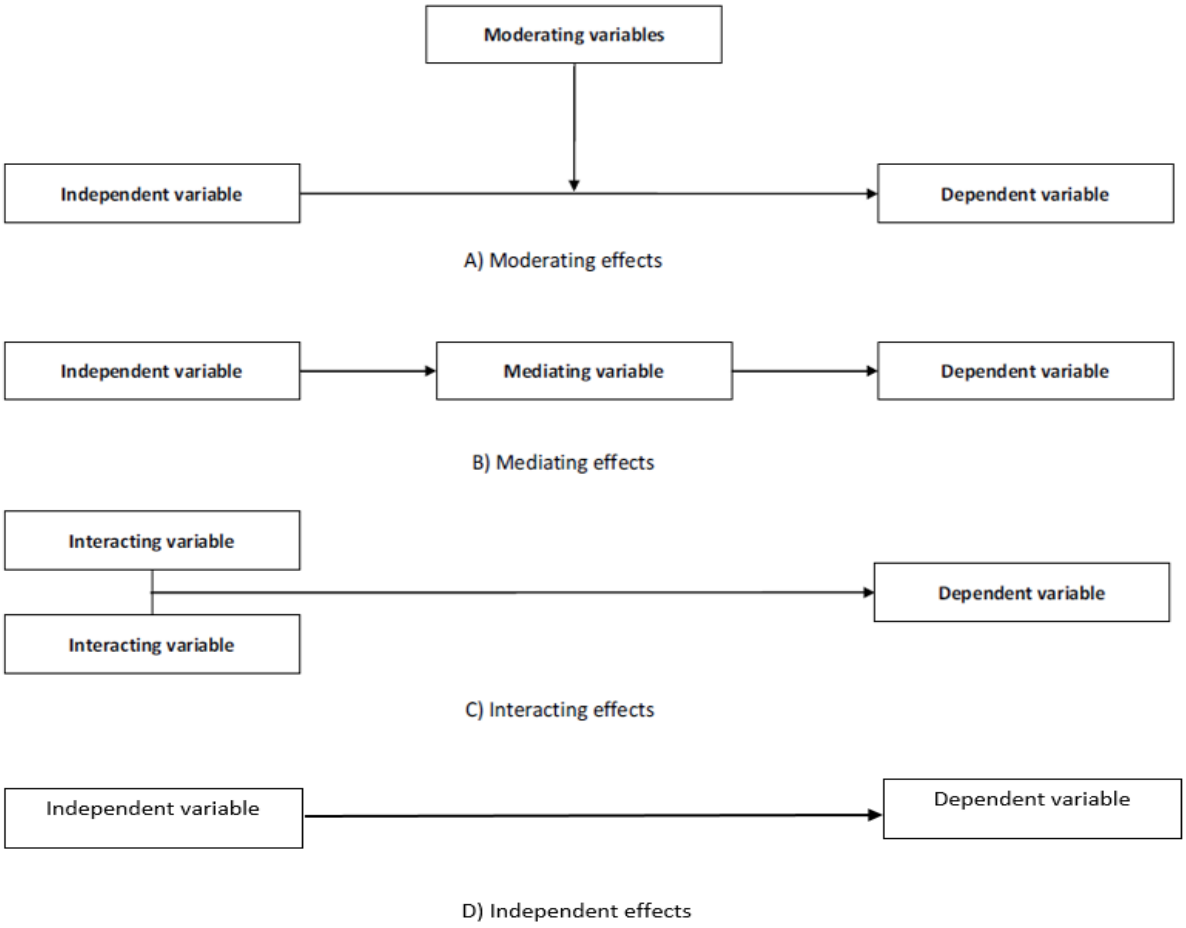

Figure 0-1: Types of contingent modelling strategies (Adapted from: Lumpkin and Dess, 1996).

3.2.3 Integrated Causal Framework for Examining Servitization Antecedents and Performance Impact

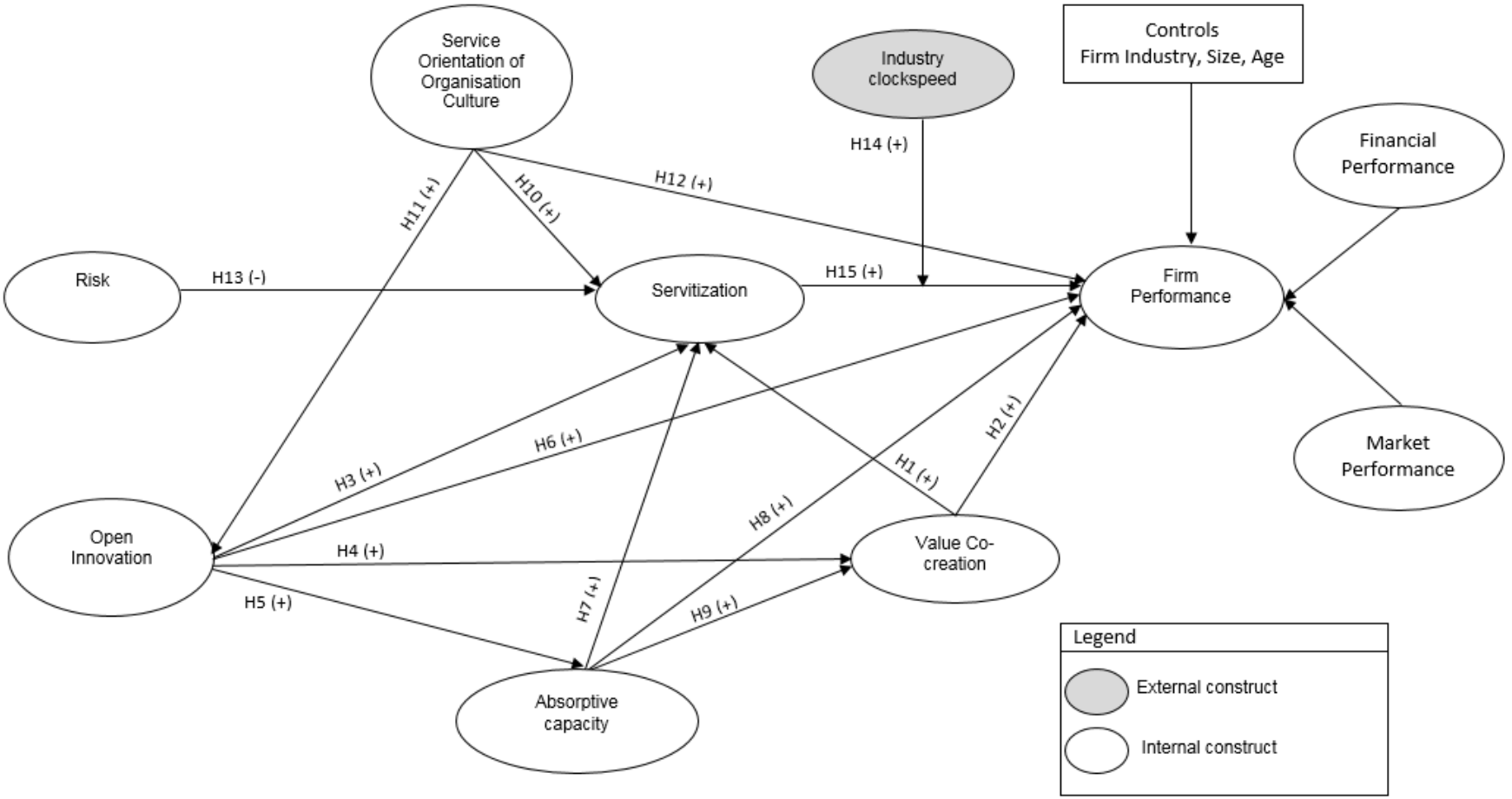

Figure 0-2: Servitization Basic Model (SBM) (Source: Aboufoul and Ruizalba, 2017).

Figure 3-2 depicts the posited conceptual framework for this research, in which the most relevant concepts and variables have been incorporated in an integrative way (Aboufoul and Ruizalba, 2017), while also addressing the causal relationships among the IVs, many of which influence firm performance (the DV) in a servitized context. This causal framework provides the basis for a mathematical transformation of the proposed model for use in structural equation modelling.

3.3 Modelling the Internal Factors that Influence Servitization Strategies and Firm Performance

3.3.1 Value Co-Creation

Value co-creation (VCC) has recently caught the attention of both academics and practitioners; this term usually refers to the collaboration between the organization and external stakeholders (Prahalad and Ramaswamy, 2000). The research interest in VCC has taken different directions, fuelled by the seminal work of Vargo and Lusch (2004) on a co-creative service-dominant logic (SDL) of marketing. The VCC concept has also influenced the examination of customer relationships in the context of relationship marketing (e.g., Oliver, 1999), co-production (e.g., Morgan and Hunt, 1994), co-design (e.g., Fournier, 1998), self-service (e.g., Holbrook and Hirschman, 1982) and experiential marketing (Pine and Gilmore, 1998).

The traditional paradigm of value creation mainly relies on the distinction between the roles of the producer and the consumer in the value creation process: one provides and the other receives. This type of value is usually referred to as value-in-exchange (Macdonald et al., 2011).

The exchange of value is performed in the marketplace between different actors, where the product and services are considered the sources of value. With the introduction of the service-dominant logic (SDL), however, this distinction has faded away. In SDL context, companies and customers are viewed as an integrated entity, with reciprocal benefits creating a new form of value called value-in-use. The main premise of the SDL is the interaction between the organization and the

customer, which harnesses the dialogical and personalized interaction for joint value creation (Prahalad and Ramaswamy, 2004b).

In this context, it is important to define the concept of value co-creation (VCC). The most cited definition of co-creation was introduced by Prahalad and Ramaswamy (2000), who define co-creation as

> a form of market or business strategy that emphasizes the generation and ongoing realization of mutual firm-customer value. It views markets as forums for firms and active customers to share combine and renew each other's resources and capabilities to create value through new forms of interaction, service and learning mechanisms. (p. 15)

In a further elaboration of the concept of co-creation, Payne et al. (2008) propose a typology and conceptual framework in which co-creation includes: (a) dynamic participation among at least two actors; (b) resource integration to create mutually beneficial value; (c) willingness to interact with other actors; and (d) a continuum of possible forms of collaboration. Building on these factors, Payne et al. (2008) define co-creation as

> an interactive process involving at least two willing resource integrating actors which are engaged in specific form(s) of mutually beneficial collaboration, resulting in value creation for those actors. (p. 201)

To provide an additional perspective on the value co-creation process, Grönroos (2008) proposes three overarching elements that facilitate the co-creation of the outcome: the customer sphere, the supplier sphere, and the joint sphere. In the joint sphere, or the area of where the customer and supplier spheres overlap, value is created by actual use. This value-in-use concept is dynamic concept and changes depending on the customer's goals (Füller, 2010; Macdonald et al., 2011).

The VCC construct also encapsulates many components that are fundamental to understand for this research. These components are as follows:

- **Co-production,** which can take the form of direct or indirect "co-working with customers" (Nuttavuthisit, 2010), active participation in the product/service design process (Fang et al., 2008), or integration of mutual resources into the value configuration (Ballantyne and Varey 2008). However, Vargo and Lusch (2004) argue that the locus of control in co-production resides with the firm, which defines the nature and extent of co-production. Nevertheless, the research favours Hunt et al.'s (2012) reasoning that in the co-production context, outcomes are jointly produced, with only a slight emphasis on the supplier role.

- **Knowledge sharing,** which is considered a basic operant resource that encompasses the sharing of consumers' knowledge, ideas, and creativity (Zhang and Chen, 2008). The act of sharing data and information results in better outcomes compared with working independently, due to reconciliation, shared inventiveness, and better communication and assessment of needs (Enz and Lambert, 2012)

- **Relationship,** which includes strong joint, reciprocal, and iterative processes between the customer and the business environment. In this context, the role of relationship and collaboration is to empower customers to develop solutions (Bonsu and Darmody, 2008), thereby creating value.

- **Personalization,** which refers to the distinctiveness of the actual or perceived use process, in which value is widely perceived as being contingent on individual characteristics (Karpen et al., 2012; Lemke et al., 2011). The main benefit of a personalized proposition is that it extends the boundaries of realized consumer value and facilitates a vital reconfiguration of the future production of use and exchange value, even beyond the scope and the purview of companies and consumers (Cova et al., 2011).

- **Value in use,** which refers to the idea in which the value is extended beyond the co-production, exchange, and possession of the physical artefact or service. Therein, value is co-

created in use as the consumer evaluates and defines the value of a particular proposition on the basis of its usage specificity (Vargo and Lusch, 2004, 2008). Furthermore, value can be a result of the interaction between the company and its market offerings. It can also derive from the process of actual consumption, which may be mostly independent of the company's involvement or exchange (Grönroos, 2006; Vargo and Lusch, 2004). Therefore, the present paper maintains the view that value for customers emerges in the customer's domain during usage (Grönroos and Ravald, 2011).

It is highly important to understand why value co-creation is considered to be at the heart of the service dominant logic, especially in manufacturing firms. In this perspective, the manufacturer can only make the value proposition, while the customer realises the value through actual use and through the value generation process (Grönroos and Gummerus, 2014). The S-D logic's main principle is that services are exchanged with services. The SDL also stresses the equality between different actors in the network, making it of high importance in a B2B context (Vargo and Lusch, 2008). Furthermore, the S-D logic highlights the importance of operant resources, for instance, skills and knowledge. This perspective emphasises the joint development efforts between the firm, the customer, and any other stakeholders in the ecosystem, in performing a service and contributing to value co-creation. It emphasises the notion that value "is always determined by the beneficiary" (Vargo et al., 2008, p.148).

In addition, manufacturing firms are increasingly endorsing a rigorous feedback mechanism to collect data from different actors in the value co-creation process; this helps firms to enhance their knowledge base through improved personalization of customer solutions (Hunt, 2000; Lusch et al., 2007). Feedback from the value co-creation process can help firms to develop new dynamic capabilities, enabling them to respond to changes in the business ecology. Moreover, it can help companies avoid a competency trap, in which competencies become irrelevant due to changes in the business sphere (Teece, 2007).

The main benefit of these new capabilities is that they improve the customer's business effectiveness by supporting the customer's processes. In a B2B context, the main obligation of the solution provider is to support the processes of the receiving company by providing a service offering in a value-supporting way, and not only providing resources (Grönroos, 2011b). Furthermore, the SDL emphasises the customer's involvement in the value co-creation process, and the importance of managing customers as a partial employee of the provider. In this realm, customers become active resource integrators rather than taking a passive role (as is done in the G-D logic) during the usage of a product/service.

Ueda et al. (2008) present three models of how the value of products or services is created in the market through the interaction between producers, consumers and products/services (see figure 3-3):

- **Class I – Value-Creation Model (Added Value)**

In this setting, value for the product or service provider (producer) and receiver (consumer) can be specified independently, and the environment can be determined in advance. The model can be described as a closed system. The problem that needs to be addressed is the search for the optimal solution for the customer. Here, solution refers to the product and service components that are necessary to deliver an integrated response to the operational and business needs of the customer (Nordin and Kowalkowski, 2010).

Class II – Value-Creation Model (Adaptive Value)

In this model, the value for the product or service provider and consumer can be quantified, but the environment is changing, making it difficult to predict the optimal customer solution. The model provides a unique representation of a system that is open and sensitive to contingencies and the external environment. The problem to be addressed by the system actors is the adaptive strategy.

Class III – Value-Creation Model (Value Co-Creation)

In this setting, the value for the product or service provider and consumer cannot be realised independently. Because the two actors are interacting with one another, they cannot be separated. The producer enters the system in order to address the problem of value co-creation. This model of value co-creation encapsulates the core of the service offering. Departing from the G-D logic, the service is an intangible good, so it cannot be saved or transported, and is consumed at the time of production. The producer, the receiver, the environment and the products and the services enter the system and interact to co-create value. The problem is that the value is co-created at the service site, and this offering cannot be divided into its respective elements, which presents a problem for the system designer.

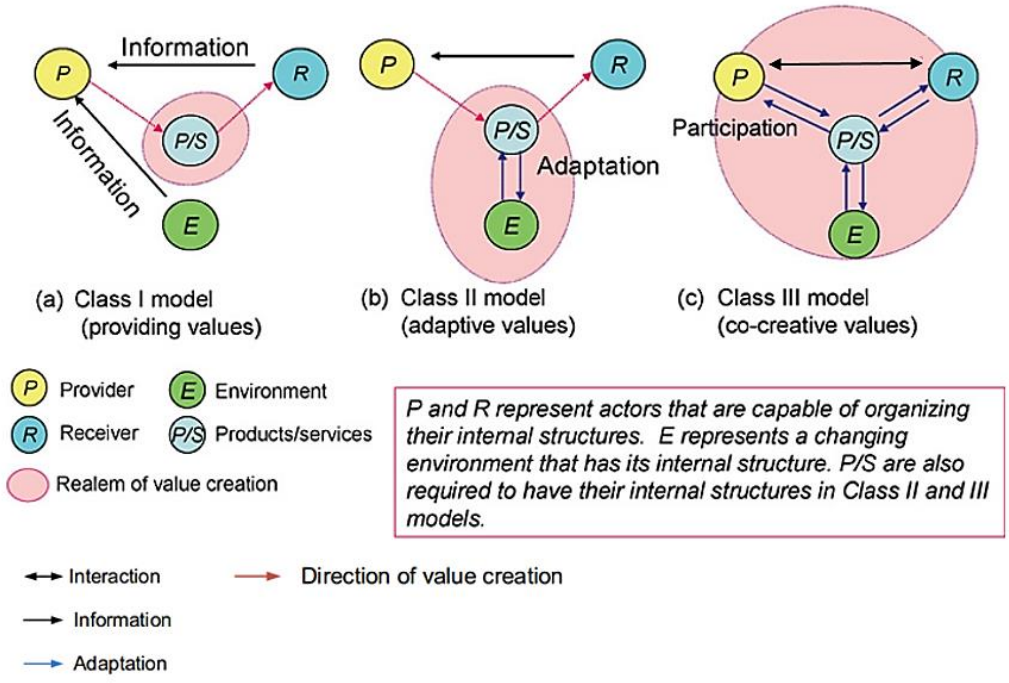

Figure 0-3: Model of value creation (Source: Ueda et al., 2008, p.55).

As discussed in Section 2.2.11, servitization entails delivering value in use by integrating one or more product and service into the market offering (Neely, 2008). This idea is also confirmed by Baines et al. (2009) with their notion that customers nowadays want manufacturers to do the job with them by providing them with a capability, especially in process-centric servitization. Since better product function does not necessarily create new value, the co-creation aspect in design and

customization ensures that the servitized offer always creates value for the customer. Furthermore, in order to deliver a servitized offering, a degree of joint development must occur to leverage value co-creation, especially during the service design phase. Moreover, the findings of Ruizalba et al. (2016) suggest that customer input and involvement in the B2B context is highly important in order to achieve servitization's benefits and enhance firm performance. Put differently, value co-creation moderates the relationship between advanced service provision and firm performance. Furthermore, as Wikström (1996a) states, "it is no longer a question of creating value for the customer; rather, it is about creating value with the customer and incorporating the customer's value creation into the system" (p. 9). Ng et al. (2010) investigated value co-creation in the context of outcome-based contracting (OBC), which is considered a special form of servitization that delivers value in use. Their findings suggest that the co-creation of value helps firms cut delivery costs and increase customer satisfaction, improving overall provider performance (Kohtamäki, Partanen, Parida, and Wincent, 2013).

This thesis conceptual framework views value co-creation as multi-dimensional construct that involves collaboration between both supplier and customer to deliver value in use (Vargo & Lusch, 2004). The main goal of value co-creation in a servitized context is to increase the productivity and/or effectiveness of both the supplier and consumer, taking into consideration that providing value in use is a dynamic process due to changes in the customer's objectives along the stages of the relationship (Macdonald, Wilson, Martinez, & Toossi, 2011). A study by Viljakainen and Toivonen, (2014) found a positive relationship between value co-creation and service infusion which leads to a higher performance.

Following this rationale, the following hypotheses are put forward:

H1: The co-creation of firm value positively influences the firm's servitization strategies.

H2: The co-creation of firm value positively influences the firm's performance.

3.3.2 Open Innovation

The emerging literature on innovation and more specifically, open innovation, argues for a need for focal organizations to transcend their boundaries by sourcing knowledge and technology externally (Felin and Zenger, 2013). The increase in global competition and rising cost of R&D activities hinder firms' ability to survive simply by relying on the traditional internal and closed innovation paradigm. Therefore, organisations should tap external sources of knowledge that are relevant to the organisation in order to incorporate this knowledge into the organisation's innovation process and augment in-house research and development (R&D) (Wolpert, 2002; Chesbrough, 2006c). In this context, open innovation is defined as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using [pecuniary and non-pecuniary] mechanisms in line with the organization's business model" (Chesbrough et al., 2014, p. 27).

The core idea behind the open innovation paradigm described by Chesbrough (2003) is that organizations reliance on internal R&D) may lead to missed business opportunities because important sources of innovation exist outside the organization's boundaries. Thus, firms should seek to introduce an open innovation strategy to capture internal and external paths to market.

Advances in ICT and network technologies play a central role in helping organizations embed open innovation strategies and facilitate collaboration with external knowledge partners in the ecosystem (Tushman, Lakhani, and Lifshitz-Assaf, 2012). The literature on open innovation and firm openness suggests that organizations that fail to pursue an openness strategy may manifest organizational myopia (Laursen and Salter, 2006), in which managers overestimate internal sources and underestimate external sources. In the context of open innovation, three fundamental principles are essential in this research for understanding the concept.

First, open innovation is a broad concept that encompasses both purposive inflows and outflows of knowledge. Purposive inflows, also referred to as inbound open innovation, allow the organisation to align its internal innovation activities with external sources of knowledge to improve

the firm's existing technological developments. Internal purposive outflows of knowledge, or outbound open innovation, are innovation activities that leverage the current technological capabilities outside the boundaries of the organization (Laursen and Salter, 2006).

Second, there is wide agreement in the open innovation literature that organizations pursuing open innovation strategies should have a certain degree of permeability at the firm level, and more specifically, at the innovation process boundaries, to ensure successful innovation (Laursen and Salter, 2006).

Third, the extant open innovation literature argues that the concept is quite wide; it is considered an "umbrella that encompasses, connects and integrates a range of already existing activities" (Huizingh, 2011, p. 3). Consequently, the spectrum of organisational practices that can be qualified as an open innovation activity is wide and varied. For instance, the following organisational practices fall, by definition, under the category of inbound open innovation: engaging in R&D alliances, scanning the external environment for new technologies, participating in crowd sourcing, forming a joint venture, licensing technology from a university, and participating in broad networks to coordinate innovative activities (cf., Petroni, Venturini, and Verbano, 2011; van de Vrande, Lemmens, and Vanhaverbeke, 2006).

In terms of manufacturing firms, these firms traditionally depend on internal R&D activities, which are considered to be an important dynamic capability by which manufacturers create and develop new products and services. Furthermore, internal R&D functions are considered to be of strategic importance and are widely regarded as an entry barrier for potential competitors (Teece, 1986). The process by which traditional manufacturing firms discover, develop and commercialize products internally has been classified as the closed innovation model (Chesbrough, 2003). Even though this traditional box-push model in manufacturing has thrived for quite a long period, the organisational and innovation landscape has evolved in recent times. Due to changes in the division of labour, a surge in venture capital, and the diversity of knowledge sources across multiple public and

private organisations, manufacturers can no longer afford to innovate on their own, but rather need to engage in alternative innovation practices (van de Vrande et al., 2009). Manufacturers are now called to introduce open innovation strategies by combining technological exploitation with exploration in order to maximize the value created from their technological capabilities and core competencies (Chesbrough and Crowther, 2006; Lichtenthaler, 2008).

Open innovation (OI) has proven to be beneficial to manufacturing firms, helping them reduce time to market, lower costs, increase access to additional competencies, increase access to new markets, and accelerate innovation through collaboration (Chesbrough, 2011). The 'not invented here' (NIH) syndrome, which is considered one of the greatest obstacles to the implementation of OI, can be defined as "the tendency of a project group of stable composition to believe that it possesses a monopoly of knowledge in its field, which leads it to reject new ideas from outsiders to the detriment of its performance" (Katz and Allen, 1982, p. 7). This syndrome widely exists in the closed innovation model, which advocates the segregation of internal and external paths to market. The open innovation model stands in contrast to this traditional model of closed innovation. In an open innovation model (see figure 3-4), manufacturers maintain close relationships with external parties at different stages of the innovation development process in order to accelerate product or service launches. Newly developed products and services can be introduced to the marketplace via many different distribution channels, such as patent licensing, joint venture leasing, or also more traditional paths to market (Chesbrough, 2004).

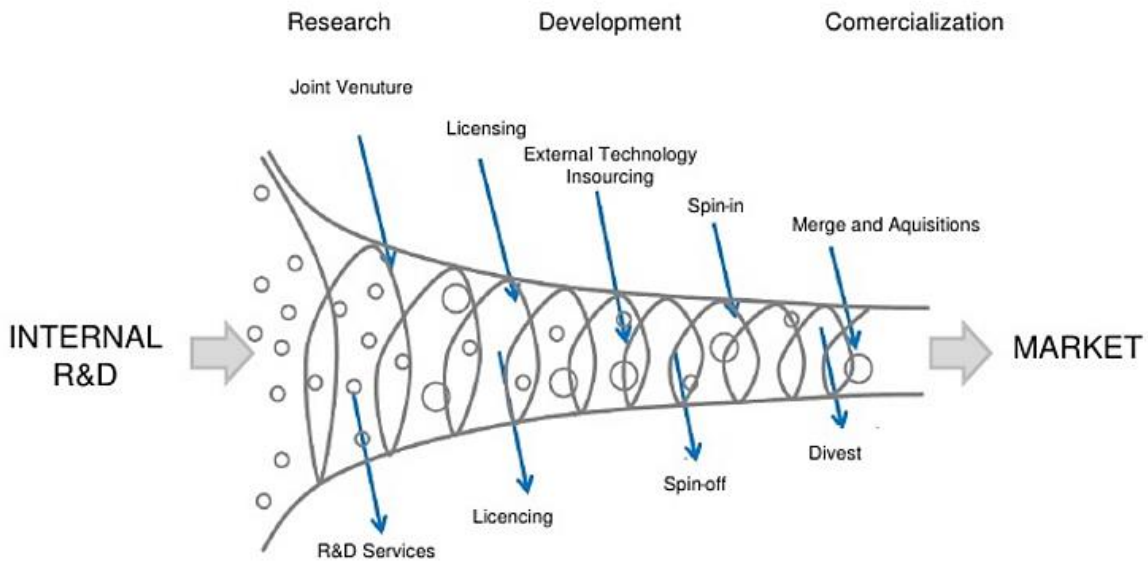

Figure 0-4: Open innovation model – the innovation funnel (Source: Lazzarotti and Manzini, 2009).

In the field of innovation management, Chesbrough (2011) argues that manufacturing firms' increasing service offerings are growing into an important cornerstone of their market offering. In addition, services are no longer the remit of dedicated service providers, but rather reflect a broader business model adopted by manufacturing firms to capture additional value or retain their customer base.

However, offering complex bundles of products, processes and services involves some organisational challenges, specifically with regard to the firm's knowledge base. Such a situation is likely to require the integration of different resources (Kogut and Zander, 1992), including external knowledge acquired from different sources, which may be necessary to sustain an integrated business model (Chesbrough, 2011). Therefore, in order to achieve a higher degree of openness, firms need to consider making a fundamental change to their business model to harnesses external resources. This idea builds on the literature of business model innovation, which emphasises the need to investigate how firms develop, deliver and appropriate value and how firms can change their business architecture to adapt to new environments, sustain competitive advantages, or generate extra profit (Zott et al., 2011). Chesbrough (2011) consider open innovation to be an antecedent to open service innovation and a catalyst to business model innovation, especially when creating a platform that

intertwines the firm's products and services and invites other actors to participate in creating the servitization platform. In this context, Visnjic and Looy (2013) refer to servitization as a unique form of open service innovation in which an organization develops its innovation capabilities by undergoing a shift away from products toward product-service systems, thereby better satisfying customer needs, escaping the commoditization trap, and enhancing the service offering.

A plethora of studies on open innovation advocates that the network of relationships between the firm and its external environment can play a significant role in influencing the firm's performance. Therefore, the author argues that manufacturers that are more open to exploiting external sources to acquire knowledge and pooling technological opportunities to develop new market offerings will have a higher level of innovative performance and better overall firm performance (Laurson and Salter, 2006). Laurson and Salter (2006) carried out an empirical study of the strategies that firms use when introducing open innovation, looking specifically at the impact of openness in terms of the breadth and depth of the external search for innovation and its influence on financial performance (as measured by share of income from new products). The study, which was based on a large sample of manufacturers from the UK, revealed an inverted U-shaped relationship between the depth of the external search on the one hand and innovative performance on the other, and showed that firms may over-search, hindering their performance (Laursen and Salter, 2006).

According to Chesbrough (2011), the move towards services and the resulting increase in customer focus can be seen as an innovation of the business model and an adoption of open service innovation practices, reflecting the main premises of servitization. Moreover, the author argues here that manufacturing firms that adopt open innovation practices must develop new capabilities and business models to successfully acquire and integrate external knowledge that helps in developing servitized offers (Chesbrough, 2006; Lichtenthaler and Lichtenthaler, 2009).

More recently, the open innovation research has started to consider co-creative interactions with consumers as part of product development and value creation (Hippel, 2006; Tseng and Piller, 2003;

Potts et al., 2008). Redlich et al. (2014) examined the relationship between open innovation and value co-creation in manufacturing firms in the context of PSS and found that it is highly important for manufacturing firms to actively promote openness in order to tap the potential of value co-creation. Furthermore, openness was found to a key antecedent to value co-creation in a production network.

The research of Martinez (2013) confirms this relationship, and further emphasise these benefits related to opening the firm's boundaries, firms need to consider a fundamental change to their business model in order to achieve a higher degree of openness. In this sense, Chesbrough (2011) considers open innovation to be an antecedent to open service innovation and a catalyst to business model innovation, especially for creating a platform that intertwines the firm's products, services, and information in order to invite other actors to participate in creating the servitization platform. Visnjic Kastalli and Van Looy (2013) refer to servitization as a unique form of 'open service innovation,' in which an organization develops its innovation capabilities by undergoing a shift from products to product-service systems, thereby better satisfying customer needs, escaping the commoditization trap, and enhancing the service offering, they also found a positive association between open innovation and service innovation in the manufacturing context. Following this line of inquiry, this research argues that manufacturing firms that adopt open innovation practices need to develop specific dynamic capabilities and a specific business model to successfully acquire and integrate external knowledge (Chesbrough & Crowther, 2006; Lichtenthaler & Ernst, 2009). Therefore, in the manufacturing context, tapping network externalities that promote and enable open innovation can support service innovation and servitization strategies. Based on the above, the author therefore postulates the following hypotheses:

H3: The firm's open innovation activities positively influence the firm's servitization strategies.

H4: The firm's open innovation activities positively influence the firm's value co-creation.

H5: The firm's absorptive capacity positively influences the firm's open innovation.

H6: The firm's open innovation activities positively influence the firm's performance.

3.3.3 Absorptive Capacity

For manufacturing firms, it is considered axiomatic that to successfully introduce innovative products and services requires the assimilation of both external knowledge and internal innovation practices (Volberda, Foss, and Lyles, 2010). The concept of absorptive capacity, which emerged from macroeconomics (Adler, 1965), refers to the ability of an economy to utilize and absorb external information and resources. This term has been widely used in the organizational research and is considered a significant construct in a number of management fields, such as strategic management, industrial economics, resource-based view, and dynamic capabilities, making it a multidisciplinary term (Schmidt, 2010; Zahra and George, 2002). Furthermore, this term was introduced at the firm level Cohen and Levinthal (1989), who later defined it as the "ability of an organization to *recognize* the value of new information, *assimilate it*, and *apply it to commercial ends"* (Cohen and Levinthal, 1990; p. 128). The central idea of this concept is that a firm's ability to accumulate experience with any technological adoption or invention in turn improves its capacity to recognize and absorb influential external ideas and create valuable inventions in the form of new products, services, or a combination thereof (King and Lakhani, 2011).

The role that absorptive capacity plays in fostering manufacturers' growth mainly depends on the firm's set of organizational routines and configuration of internal dynamic capabilities (Reilly and Scott, 2010). One can argue that organizational learning capabilities are central to providing a solution to a customer's problem (Davies and Brady, 2000), and therefore absorptive capacity is considered an important organisational capability that manufacturing firms must leverage to better implement servitization or create and deploy the knowledge necessary to build other organizational capabilities (Todorova and Durisin, 2007). In the context of manufacturing, rapid technological advancement coupled with ever changing customer needs has pushed firms to screen their environment for new ideas for leveraging their new product development (NPD) processes (Zahay, Griffin, and Fredericks, 2004).

In line with Cohen and Levinthal's (1990) seminal paper, absorptive capacity is usually operationalised as the existence and/or intensity of a company's R&D activities (Veugelers, 1997; Lane and Lubatkin, 1998; Lin, 2003; Oltra and Flor, 2003; Leahy and Neary, 2007; Zahra and Hayton, 2008). Later research has broadened the concept to include the development of absorptive capacity at the organisational level (Lichtenthaler, 2009; Tsai, 2001).

Drawing on dynamic capability theory, Zahra and George (2002) reconceptualise absorptive capacity as a dynamic organizational capability consisting of four dimensions: acquiring, assimilation, transformation and exploitation. These dimensions allow incumbents to adapt to the market dynamism by reconfiguring the firm's resource base and its organizational routines and practices (Spithoven et al., 2011).

- **Absorptive Capacity and its Dimensions**

Absorptive capacity is widely viewed as a facilitator of internal innovation practices for organizations (Todorova and Durisin (2007). Hence, in order to better operationalize this construct in the present research, its main components are worth a deep investigation. This research will adopt the most recent conceptualization of the construct by Todorova and Durisin (2007), who suggested that absorptive capacity encapsulates the following temporal dimensions: acquisition, transformation, assimilation, and exploitation (see figure 3-5).

These four components can be divided into two distinct categories of absorptive capacity: potential and realized, where the former consists of acquisition and assimilation and latter of transformation and exploitation (Zahra and George, 2002). It is important to clarify that the internal antecedents of absorptive capacity are paramount and cannot be dismissed, but they lay outside the scope of this research model and therefore will not be dealt with (for further information see Cohen and Levinthal, 1990, p. 131). Furthermore, Zahra and George (2002) argued that organisations "can acquire and assimilate knowledge but might not have the capability to transform and exploit the knowledge for profit generation" (p. 191). This notion paves the way for this study's attempt to

investigate these components (dimensions and component are used interchangeably) in greater detail, as will be done below.

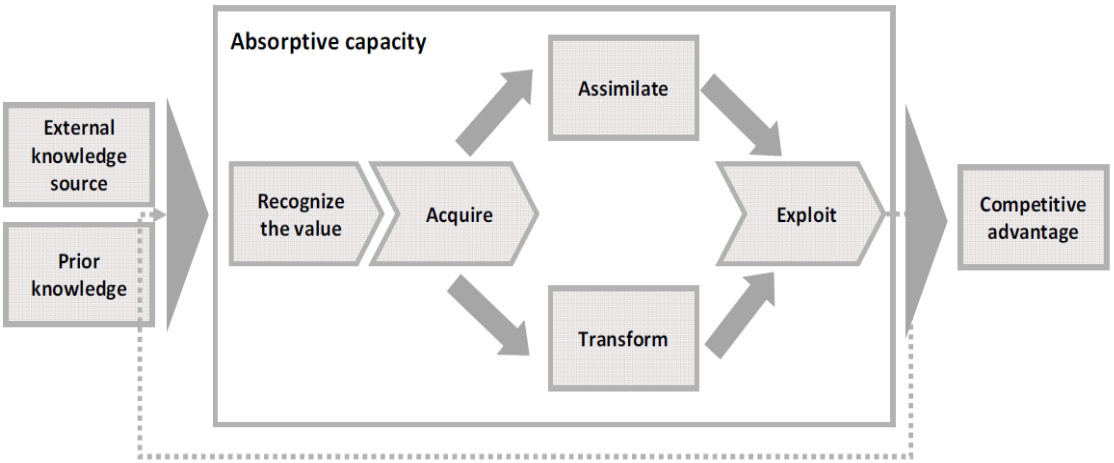

Figure 0-5: Major dimensions of absorptive capacity (Based on Todovora and Durisin, 2007).

a) Knowledge acquisition

This first key component of absorptive capacity refers to the firm's ability to acquire new external knowledge that is critical to its operations (Zahra and George, 2002). This component emphasises the active screening of the environment and any relevant sources to identify potentially relevant knowledge. This practice should not be constrained to a specific function within the organization; rather, it should be perceived as an organization-wide activity with the purpose of achieving ultimate absorption of knowledge.

b) Knowledge assimilation

This dimension encompasses the way the firm communicates, interprets and internalizes the knowledge collected across firm boundaries. This dissemination of knowledge requires the substantial flow and sharing of data between different business functions and individuals in order to capitalize on the acquired knowledge. This process of knowledge assimilation sometimes requires reconfiguration of the firm resources and a restructuring of the business functions to maximise the internal network's

capacity to disseminate knowledge and cooperate. However, Zahra and George (2002) argue that the successful dissemination of knowledge requires a deep understanding of how the collected knowledge is structured and embedded at its source. This important understanding will determine how easy or difficult it will be to assimilate the acquired knowledge.

c) Transformation

The third component of absorptive capacity entails the refinement and conversion of the assimilated knowledge to fit the firm's existing cognitive schema, while tailoring it to the business function's idiosyncratic needs (Todorova and Durisin, 2007). The modification of internalized knowledge to fit the firm's distinct needs is widely rooted in the learning process implemented inside the firm. Lane and Lubatkin (1998) put forth the dyadic student-teacher typology to refer to the process firms use to absorb and transform knowledge, stating that "student firms have the greatest potential to learn from teachers with similar basic knowledge but different specialized knowledge" (p. 464). This notion is grounded in the DCT, in which the knowledge transformation capabilities inside the firm are dependent on previous investments into absorptive capacity applications and the firm's prior experience. This path dependency enhances the firm's positional advantage, allowing it to better internalize the external knowledge and adapt more easily within the marketplace (Teece, 1997). Moreover, in the DCT context, Zahra and George (2002) suggest that "the ability of firms to recognize two apparently incongruous sets of information and then combine them to arrive at a new schema represents a transformation capability" (p. 190).

d) Exploitation of knowledge

The final component of absorptive capacity is the process by which the newly absorbed capabilities are leveraged. The importance of internal organizational innovation practices, especially in terms of human capital abilities, is profoundly important to the exploitation process (Minbaeva et al., 2003). The existing research on managerial cognitive abilities emphasises the role that managerial aptitudes

play in influencing new product and service development trajectories and the corresponding exploitation of capabilities (Dosi, 1982). Furthermore, one can argue that the lack of managerial cognitive abilities and skills can stem from organisational inertia (Tripas and Gavetti, 2000). In other words, the process of exploiting acquired knowledge is pivotal to actually realising the potential of incorporating absorptive capacity in a manufacturing firm (Barringer and Bluedorn, 1999).

Nevertheless, the antecedent role of absorptive capacity has been neglected in the servitization literature. While no study on servitization has highlighted whether absorptive capacity positively influences servitization adoption or has any association with servitization construct, the existing quantitative empirical research has revealed that absorptive capacity has a positive impact on the process of new product development and R&D practices (Stock et al., 2001). Furthermore, Koçoğlu et al.'s (2015) findings confirm that absorptive capacity is one of the main drivers of product innovation in manufacturing firms. The ability to develop innovative new products, particularly within high-technology industries, can be a key determinant of competitive advantage (Brown and Eisenhardt, 1995; Rosenthal, 1992). Therefore, firms seek to increase their innovation capabilities by tapping into external knowledge sources; they do so by opening inbound open innovation systems (Chesbrough, 2003b).

Parallel to this, Kranz et al. (2016) found a positive impact of absorptive capacity on the process of business model change. This was also confirmed by the previous finding that absorptive capacity increases a firm's "capacity to correctly generalise and link internal with external knowledge to increase its responsiveness to customer needs" (Weigelt and Sarkar, 2012, p. 196). Symeou and Kretschmer (2013) explored the drivers of manufacturing firm performance and found a positive impact of the four dimensions of absorptive capacity on firm performance. These findings are in line with Grant's (1996) research, which found that superior profitability is fundamentally related to the technology, knowledge resources and capability-based advantages in firms, rather than merely positioning advantages. Furthermore, researchers (e.g., Chen, Lin and Chang, 2009) have suggested

that absorptive capacity is a fundamental determinant of innovation performance, and further empirical research has confirmed that there exists a direct positive relationship between absorptive capacity and firm performance (e.g., George, Zahra, Wheatley, and Khan, 2001; Lane, Salk, and Lyles, 2001; Tsai, 2001). These findings are based on the notion that the more information a firm gather through the search for external knowledge, the better its chances for recognising changes in the environment, leading to improved performance. Furthermore, in terms of the relationship between absorptive capacity and value co-creation, the empirical findings of Komulainen (2014) suggest that firms with a higher degree of absorptive capacity, an explorative learning orientation, and a0 willingness to invest in learning, were more successful at obtaining the benefits of value co-creation. Therefore, absorptive capacity is an important antecedent to firm value co-creation.

As previously mentioned in Section 2.7, this research conceptualizes servitization as a change in the manufacturing business model and its interlocking elements in order to accommodate service provision in the firm's market offerings (Barnett et al., 2013). This follows the fundamental idea that absorptive capacity is an organisational capability reflecting a firm's receptivity to technological change (Kedia and Bhagat, 1988), and builds on the resource/capability-based view and the knowledge-based view of the firm (Grant, 1996), which argue that firms must acquire capability-based advantages and innovate firm capabilities in order to deliver a servitized offer. As mentioned before, when absorptive capacity is realized, a firm may increase its growth by "exploiting existing internal and external firm-specific competencies to address changing environments" (Teece et al., 1997, p. 510). This is an established theme in the strategic management and innovation literatures, which also suggest that firms increasingly need to rely on external knowledge sources to advance and sustain competitive advantages, which can be fostered through intra-firm adoption of absorptive capacity initiatives (Teece, 2007; Chesbrough, 2003). Cohen and Levinthal (1990) suggest that R&D has "two faces" (inside and outside the firm) and assert the importance of investing in internal research in order to be able to utilize external technology, an ability they term "absorptive capacity" and consider an important antecedent to an open innovation paradigm. In line with this argument, Laursen and Salter's

(2006) empirical findings confirm this relationship, in which absorptive capacity is considered to be complementary to open innovation. This complementary relationship enhances the firm's overall competitive advantage if both practices (absorptive capacity and open innovation) exist simultaneously.

Although the role of absorptive capacity as a dynamic capability (Zahra & George, 2002) has thus far not been discussed in the servitization research, the exploitation of new knowledge in the manufacturing context through absorptive capacity is paramount to promoting the flexibility needed to compete in a dynamic and evolving marketplace (Ambrosini & Bowman, 2009).

In line with this argument, Hayes and Pisano (1994) suggest that diverse markets and fierce global competition require a higher degree of strategic flexibility on the part of manufacturing firms; this can fostered by recognising the value of newly acquired external knowledge, assimilating it and then applying it to commercial means. Therefore, a firm's growth mainly depends on knowledge acquisition and learning, especially in SMEs (Altinay, Madanoglu, De Vita, Arasli, & Ekinci, 2016).

From the above, it becomes clear that innovation success within manufacturing firms depends predominantly on absorptive capacities that target technological knowledge. On the one hand, absorptive capacity creates opportunities for manufacturing firms in their shift to service provision by allowing them to acquire the capabilities required to deliver a servitized offer. On the other hand, it is considered an important organizational antecedent (Felin and Foss, 2006). Following the aforementioned reasoning, and based on our discussion of absorptive capacity and the empirical evidence from prior literature, the author puts forward the following hypotheses:

H7: The firm's absorptive capacity positively influences the firm's servitization strategies.

H 8: The firm's absorptive capacity positively influences the firm's performance.

H9: The firm's absorptive capacity positively influences the firm's value co-creation.

3.3.4 Service Orientation of Organisation Culture

The concept of organizational culture originated in cultural anthropology and is popular within the organizational behaviour, management, and marketing literature (e.g., Gregory et al., 2009; Homburg and Pflesser, 2000; Schein, 2004). Furthermore, corporate culture is considered an important organizational 'soft factor' (Homburg, Fassnacht and Guenther, 2003), especially in the highly competitive industrial markets. In this context, organizational culture is defined by Deshpand and Webster (1989, p. 4) as "the pattern of shared values and beliefs that help individuals understand organizational functioning and that provide norms for behaviour in the organization." Schein (2004), however, provides the most commonly cited definition of culture as

> a pattern of shared basic assumptions that the group learn[s] as it solve[s] its problems of external adaptation and internal integration that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems. (p.17)

Organizational culture is a profound resource that is difficult for competitors to imitate and hard to substitute without exerting a great deal of effort (Hoopes et al., 2003). It also plays a key role in determining the level of organisational performance (Narver and Slater, 1990)

Prior research indicates that manufacturing firms that are shifting towards providing service or augmenting their core offering with services require significant internal changes in terms of management philosophy and approach (Homburg, Fassnacht, and Guenther 2003). The effect of organizational (corporate) culture on firms is twofold: first, it affects the organization's choice of desired outcomes, and second, it affects the means to achieving these outcomes. It also influences the organizational structure and internal processes as the firm changes its business model to suit the immediate environment (Gebauer et al., 2009; Deshpande, Farley, and Webster, 1993; Quinn and Rohrbaugh, 1983).

The servitization literature suggests that a shift in organizational culture and mindset is required to move from a product-oriented organization to a service-oriented one (Nuutinen and

Lappalainen, 2012; Brax, 2005; Finne, Brax, and Holmström, 2013). Consequently, in terms of achieving a service orientation of organisational culture within industrial marketing companies, Schein (2004) suggests that these companies have two types of organizational culture: a product orientation and a service orientation, both of which influence firm performance (Gebauer et al., 2009; Neu and Brown, 2005). The former is considered to create competitive advantage by focusing of the engineering side of the product, stressing product functionality, features, durability, reliability, conformance quality and design, while the latter is concerned with the service-related issues such as pre- and after-sales services, including consulting, training, installation, asset management, maintenance and repair. In general, one is not considered superior to the other (Gebauer et al., 2009; Kotler and Keller, 2012).

Empirical research that investigated manufacturers' transition from selling products to providing services found a positive association between a service-oriented culture of the firm and overall firm performance (Gebauer et al., 2009). Other findings also suggest that a service-oriented culture in manufacturing firms encompasses the values and behaviours linked with an entrepreneurial orientation, real problem-solving willingness, innovativeness, and the resilience of service employees (Matthyssens and Vandenbempt, 1998).

In the present research, a service orientation of organisational culture is measured quantitatively, as recommended by Gebauer (2008), because it is considered a sub-aspect of the overall organizational culture. Furthermore, service-related aspects are widely evaluated in a quantifiable manner in organizational research (Parasuraman and Zeithaml, 1991). In the present study, organisational culture is analysed through the lens of the attention-based view of the firm, which stresses the role that managerial cognition and actions play in shaping the organisational culture as well as a variety of organizational phenomena, such as strategic decision-making (Barr, Stimpert, and Huff 1992). Furthermore, from the DCT perspective, it is argued that culture can be conceptualized as a governance system (control on the cheap) that influences employee behaviour

without the need for strict administrative management methods (Eisenhardt and Martin, 2000; Teece et al., 1997), in this context the author argues that servitization adoption is the strategic decision made by top management to shift into service provision (Baines et al., 2009; Neely, 2013). In this context, Homburg et al. (2003) suggest that a service orientation of organisational culture can be divided into two main components. The first component is the intrinsic value of services, as perceived by managers and employees, who attempt to manifest this value in their day-to-day job responsibilities. The second component is the degree to which managers and employees behave in a service-oriented manner.

All in all, a service orientation of organisational culture has a positive impact on service-related performance outcomes and overall profitability (Homburg et al., 2003; Neu and Brown 2005), and it has been empirically shown to have a positive impact on the alignment between the external environment, strategy, and organizational design, and more specifically on the formulation and implementation of a strategy for offering customer support services (Gebauer et al., 2008). Parveen et al. (2015) confirm this, with their study showing a significant positive impact of organizational culture on open innovation; here, culture plays a critical role in enhancing the process of searching for new knowledge (Anderson and West, 1996), and is considered a critical enabler and success factor for open innovation (Balsano et al., 2008). Following the aforementioned reasoning, the author puts forward the following hypotheses:

H10: A service orientation of organisational culture positively influences the firm's servitization strategies.

H11: A service orientation of organisational culture positively influences the firm's open innovation strategy.

H12: A service orientation of organisational culture positively influences the firm's performance.

3.3.5 Risk

In this research, servitization is considered a strategic decision and a move by the manufacturing firm to enhance its competitive advantage via repositioning (differentiating) itself in the product-service market (Slack, 2005). In this context of servitization, risk is defined as "the estimated probability of the occurrence of any loss or any potential negative outcomes while implementing a strategy to achieve a certain objective" (Featherman and Pavlou, 2003, p. 12). Benedettini et al. (2015) studied servitization from a risk-based perspective, concluding that servitization risks derive from two blocks: external environmental risk and internal organisational risk. The first is manifested in manufacturing firms when the extension of a service offering requires the building of new relationships with the immediate environment. This type of risk usually has to do with ongoing changes in the business landscape of the manufacturing firm (Sharma and Mahajan, 1980), as manufacturers have no control over the external environment and can only prepare by means of risk management strategies (Sheth and Sisodia, 2005). As discussed in Section 2.3, servitization comes with many challenges that pose huge risks to firms, such as volatility in demand and customer expectations, changes in regulations, the capital market and ever-evolving technology (Benedettini et al., 2015). The second block of risk is manifested when the manufacturing firm needs to acquire new capabilities, new competencies, or even a new organizational structure in order to integrate a service process. Furthermore, internal risks refer to the inability of top management to make and execute sound strategic decisions due to miscalculations or a lack of understanding of the transaction costs associated with delivering services or outsourcing some core activities (Sharma and Mahajan, 1980). Such a situation can lead to a deterioration of the firm's financial health, causing it to fall behind its industry rivals, financially and technologically. The situation can be further worsened if the firm embarks on unfavourable contracts with customers or business partners; such mistakes can be fatal to the firm (Benedettini et al., 2015). This internal risk block, which is the focus of the present research, can be divided into the following subcategories commonly considered to be barriers to servitization:

- **Strategic risks:** Risks that arise from the fundamental decisions taken by management with regard to the organisation's objectives (Barid and Thomas, 1985). Essentially, strategic risks include the risk of failing to achieve business objectives and failing to implement achievable performance metrics for assessing the success of a servitized offering (Benedettini et al., 2015). Strategic risk can be derived from the fact that top management in manufacturing firms often lack the background and skills necessary to deliver services. Furthermore, they may underestimate the importance of modifying the organisational structure, culture and processes to accommodate a service strategy (Gebauer and Fleisch, 2007).

- **Financial risk:** Monetary risk resulting from the financial consequences of a wrong decision taken by top management. This type of risk can be identified and prioritized through a better understanding of transaction cost theory (Viitamo, 2013). It musts be understood how a change in ownership structure alters incentives in a 'servitized' relationship; failure to understand this important risk can lead to bankruptcy risks (Benedettini et al., 2015).

- **Operational risk:** This can be broadly categorised as risk regarding the people, processes and assets related to development planning, sourcing, production, and distribution of a service. This type of risk can be caused by high exposure to third parties, lack of collaboration, and failure to achieve certain servitization outcomes due to low uptime and poor maintenance-repair-overhaul (MRO) practices. Such risk can be analysed by understanding the principle agent theory, leading to better risk mitigation strategies (Kim et al., 2007).

The servitization literature argues that manufacturing firms that provide services actually reduce their risk due to an enhancement in the quality of customer relationships (Oliva et al., 2012) and the development of capability-based competitive advantage (Wise and Baumgartner, 1999). Nevertheless, some recent research (e.g., Fang et al., 2008) has implied that manufacturing firms that are pursuing a service-led growth strategy face exposure to new risks that can negatively affect firm value, such as organisational conflict and loss of strategic focus.

At the same time, Brady et al. (2005a) suggest that manufacturers that want to deliver services (solutions) successfully must acquire certain skills that will enhance their ability to identify, evaluate, prioritize and manage long-term risks in the value stream. Recent research into servitization has found that the risk is usually transferred from the customer side to the provider side, especially when the provider is considered a system integrator (Davies, 2004), solution provider (Nordin and Kowalkowski, 2010) or process outsourcing provider (Gebauer, 2008; Raddats and Easingwood, 2010). Manufacturing firms can also deliver services supporting the product (SSP) and/or services supporting the customer (SSC), where the former refers to services that ensure proper product access or functioning (e.g., after-sale services) and the latter refers to services that optimise customer processes, actions and strategies associated with the supplied product (e.g., financing, training, spare parts management) (Benedettini et al., 2015). These two types of offerings are directly linked to the reduction of environmental risk because they enhance the firm's differentiating power, customer intimacy and personalization level (Eggert et al., 2014; Mathieu, 2001b; Raddats and Kowalkowski, 2014). Empirical findings from Benedettini et al. (2015) show that the presence of a service business increases bankruptcy risk for the supplying firm, with the risk stemming from three distinct categories: lack of management ability, misjudged corporate policy, and company characteristics. Management abilities include motivations, qualities, skills and personal characteristics. Corporate policy refers to strategy and investments, commercial, operational, finance and administration, and corporate governance. Finally, company characteristics include the company's maturity, size, industry and flexibility (Ooghe and Prijcker, 2008). The present research favours the argument that providing services increases the risk exposure faced by manufacturing firms. Following this rationale, the author postulates the following hypothesis:

H13: Risk negatively influences the firm's servitization strategy.

3.4 Modelling the External Factors Influencing Servitization Strategies and Firm Performance

3.4.1 Dynamism and Industry Clock Speed

According to Fine (1998), industry clock speed (IC) refers to the rate of change within an industry sector or change that is external to a particular industry. The swifter the rate of change, the higher the clock speed (Guimaraes, 2011). For instance, the mining industry is considered a slow-clock speed industry sector, while the computer software industry is an example of a fast-clock speed sector (Fine, 1998).

In exploring dynamic capability theory, environmental dynamism is considered an important contingency variable that shapes the type of strategy employed by the organization (Teece et al., 1997; Eisenhardt and Martin, 2000). In this dynamic environment, contingency theory can lend itself to an understanding of the industry clock speed effect when choosing a firm strategy (Chavez et al., 2012). This theory is founded on the premise that firms are not closed systems; instead, they are perpetually being exposed to environmental pressure that should be taken into account when designing the firm's strategy (Lawrence and Lorsch, 1967). Doing so should improve the design and choice of the strategy, and at the very least should help improve firm performance (Hofer, 1975).

Departing from the conceptual tautology of industry clock speed, Fine (1998) suggests that industry clock speed can be measured in terms of the rate of change of products/services, processes and organizational structures. In this paper, the product/service change rate denotes the rate of product/service introduction to the market, while change in process denotes the frequency at which dominant production processes and production technologies are substituted and changed. Finally, changes in organizational structure refer to changes such as mergers and acquisitions, CEO transitions and restructuring programmes (Fine, 1998).

Dynamism also plays a pivotal role in the manufacturer's environment; it is related to market and industry turbulence, as well as to the degree of uncertainty in both the product markets and

technology (Thornhill, 2006; Utterback, 2006). The role of industry clockspeed (IC) was investigated by O'Connor, Ravichandran and Robeson (2008), who found a moderating effect of IC on firm collaboration activities and firm performance. The IC construct is also considered an external environmental moderator of the relationship between business model change and firm performance (Jansen, van den Bosch, and Volberda, 2005; Jacobides et al., 2006; Chavez et al., 2011).

Moreover, Fine (1998) argues that companies must be able to anticipate and adapt to change in the environment in order to achieve better market performance. Fine (1998) also suggests that the most prominent goal of the firm is to understand the dynamics of processes that will help in developing principles to guide the choice of organisational design and internal organisational processes, specifically in high IC environments where firms need to appreciate and manage all their internal capabilities in order to deliver better market offerings. The recent innovation literature suggests that industry clock speed is a significant factor in evaluating company management strategies (Guimaraes, 2011; O'Connor et al., 2008; Weijermars, 2009). Generally speaking, rapidly-changing business environments generate more uncertainty and place substantially more strain on direct human relationships than more slowly-changing business environments (Hall, 1999). Consequently, manufacturing firms in fast-changing environments require better leadership, more knowledge about business conditions, and better management in general, which will impact the way the firms introduce service offerings to keep pace with the outside environment, leading to higher profitability (Visnjic et al., 2014).

Furthermore, an empirical study by Fang et al. (2008) found a moderating effect of industry turbulence on the relationship between service ratio and firm value. In highly volatile industries, mangers seek a more diversified portfolio that can help stabilize firm earnings and cash flows and increase the chances of survival (Zahra, Ireland, and Hitt, 2000).

On the other hand, in a relatively stable industrial environment, there is less need for innovation and less need for managers to quickly identify business problems and opportunities,

technologies and other resources necessary for service delivery (Handfield et al., 2000). Therefore, in the low turbulence industry context, servitization strategies have a negative impact on firm value due to complacency in the market place which hamper the growth trajectories (Fang et al., 2008). In dynamic environments, where demand is constantly shifting, opportunities become abundant and performance should be highest for those firms that have an orientation toward pursuing new opportunities. This is because such firms show a good fit between their strategic orientation and the environment (Wiklund and Shepherd, 2005).

An additional aspect when studying performance outcomes is the consideration of moderating variables. In this thesis, the author concentrate on market dynamism, which is considered the most relevant moderating variable (Slater and Narve, 1994). Building on this notion, the author argues that servitization adoption requires the manufacturing firm to be flexible and agile in order to adapt to the external environment. Therefore, this research argues that the size and the nature of the relationship between servitization and firm performance changes as a function of the industry dynamism and clock speed. Following this reasoning and rationale, the author puts forward the following hypothesis:

H14: Industry clock speed has a moderating effect on the relationship between servitization strategy and firm performance

3.5 Servitization's Impact on Firm Performance

Wise and Baumgartner (1999) argue that services could represent a more profitable long-term source of revenue than initial product sales. However, in the context of servitization, findings about the relationship between implementing services and firm performance have been vague and far from conclusive (Baines et al., 2015). This is due to a lack of empirical research investigating this relationship using a large sample (Eggert et al., 2011; Eggert et al., 2014; Fang et al., 2008). Prior research investigating the consequences of servitization suggests that servitization is a beneficial strategy by which manufacturers can differentiate themselves from competitors (Baines et al., 2009; Oliva and Kallenberg, 2003), achieve higher profitability (Suarez et al., 2013; Visnjic et al., 2014), increase their market value (Fang et al., 2008), and increase customer loyalty (Baines and Lightfoot, 2013). However, these studies provide little robust evidence of the real impact of servitization on firm performance (Crozet and Milet, 2015; Gebauer et al., 2005; Visinjic and Van Looy, 2013). In addition, the empirical research has yielded contradictory results, thus demanding more fine-grained empirical research to clarify the true nature of this relationship (Benedetti, Neely, and Swink, 2015) and to explain why the expected benefits of servitization often do not materialise – a phenomenon that is called the "service paradox" (Gebauer et al., 2005). Gebauer et al. (2005) describes the service paradox as follows:

> Most product manufacturers are confronted with the following phenomenon: companies which invest heavily in extending their service business increase their service offerings and incur higher costs, but this does not result in the expected correspondingly higher returns. Because of increasing costs and a lack of corresponding returns, the growth in service revenue fails to meet its intended objectives. We term this phenomenon the ''service paradox in manufacturing companies.'' (p.15)

This concept has also been referred to as the servitization paradox (Benedettini, Neely, and Swink, 2015) in prior empirical research. For example, Neely (2008) investigated the financial consequences of servitization and found that servitized manufacturing firms generate higher revenues but lower net profits as a percentage of revenues than pure manufacturing firms. The reasons for this are that servitized firms face higher average labour costs, working capital and net assets.

Fang et al. (2008) further investigated the effect of the service transition on firm value in U.S. firms and found a non-linear U-shaped relationship, with an improvement seen in the market value of servitized manufacturing firms. For this improvement to materialise and become noticeable, service sales and service intensity must surpass the critical level of approximately 15%-20% of total revenue. This non-linear performance effect was later confirmed by Kohtamäki et al. (2013), and Suarez et al. (2013) found a convex, non-linear relationship between advanced service implementation and financial performance, where firms with a very high level of product sales were most profitable and increasing service provision was linked with declining profitability. In contrast, the findings of Ruizalba et al. (2016) found no statistically significant direct impact of advanced services on firm performance, as this relationship was mediated by servitization consequences.

Interestingly, Chen (2010) compared Chinese and U.S. firms with regard to the impact of service orientation on firm performance, and concluded that a positive linear relationship does exist between servitization and firm performance in the U.S., while the Chinese counterparts display an inverted U-shaped relationship (Min, Wang, and Luo, 2015). Parallel to this, Zhou's (2010) empirical findings suggest that the servitization decision positively influences the firm's market performance (Tobin's q), while the servitization level negatively influences firm financial performance, as measured by return on assets (ROA), economic value-added change rate, and earnings per share (EPS). In this context and based on data from the International Manufacturing Strategy Survey, Li et al. (2013) investigated the impact of servitization on manufacturing business performance. His results reveal a positive effect of servitization on business performance in terms of both the return on sales (ROS) and return on investment (ROI). More recently, Benedetti et al. (2015) have suggested that servitization is associated with a high risk of bankruptcy and that manufacturing firms deciding to diversify via servitization can therefore expect higher returns in exchange for accepting this risk. Visnjic, Wiengarten and Neely (2014) propose that manufacturing firms should invest in product innovation processes coupled this with adequate investment into the service business model in order to enhance long-term profitability.

The recent servitization literature also suggests that many different factors can affect the impact of servitization on firm performance, such as industry clock speed and resource slack (Fang et al., 2008), the firm's socio-technical capacity, its strategic alignment (Hu et al., 2013), and network capabilities (Kohtamäki et al., 2013).

Substantial body of servitization research argued that services could represent a more profitable long-term source of revenue than initial product sales (Eggert et al., 2014). However, services are known to be knowledge-intensive, labour-intensive and hard to standardised which can increase the transaction cost and hamper profitability (Kohtamäki & Partanen, 2016). Prior servitization research which investigates the consequences of servitization, suggested that servitization is a beneficial strategy in which manufacturers can differentiate themselves from competitors (Oliva & Kallenberg, 2003), it can lead to higher profitability (Suarez et al., 2013), increase in market value (Fang et al., 2008) and increase customer loyalty (Baines & Lightfoot, 2013).

However, these studies give little robust evidence on the real impact of servitization on firm performance (Crozet & Milet, 2017; Gebauer et al., 2005; Visnjic Kastalli & Van Looy, 2013). Add to that the contradictory results produced by prior empirical studies, this lead us to the need to a fine-grained empirical research to clarify the true nature of this relationship (Benedettini et al., 2015), and further explain why the expected benefits of servitization does not materialise in many cases causes what so called the "service paradox" (Gebauer et al., 2005).

Prior empirical research investigated the financial consequences of servitization, found that servitization of manufacturers generate higher revenues but lower net profits as a percentage of revenues than pure manufacturing firms (e.g. Neely, 2008). The reasons for this are that servitized firms encounter higher average labour costs, working capital and net assets. Conversely, other scholars empirically established a positive relationship between service offerings and company outcomes (Antioco et al., 2008; Homburg et al., 2003).

For instance, the study by (Homburg et al., 2003) supported (indirect) effects of service orientation on service profitability, and overall company profitability. In a similar vein, Gebauer (2007) finds a positive relationship between the customer service support strategy and overall profitability.

Moreover, Fang et al. (2008) investigated the effect of service transition on firm value in U.S, and supported that a non-liner relationship does exist between them taking a U-shape form, thus exhibiting, an improvement of the market value of the manufacturing firm. For this improvement to materialise and become noticeable service, sales service intensity must surpass a critical level of approximately 15%–20% of the total revenue. This non-liner performance effect was later confirmed by Kohtamäki et al. (2013) and at a further point Suarez et al. (2013) found a convex, non-linear relationship between advanced service implementation and financial performance in the software industry. According to this study, firms with a very high level of product sales are most profitable, whilst rising the service provision is linked with declining profitability.

Based on the foregoing discussion, the author puts forward the following hypothesis:

H15: Servitization strategies positively influence the firm's overall performance.

3.6 Firm Performance

In investigating the servitization–performance relationship, it is essential to recognize the multidimensional nature of the performance construct (Chakravarthy, 1986). That is, different factors contribute to overall firm performance, at times leading to favourable outcomes on one performance dimension and unfavourable outcomes on a different performance dimension, as discussed in Section 3.5. For instance, ramping up investment in R&D and product innovation may lead to better penetration into new product-market domains, consequently enhancing sales growth in the long run. However, the requisite resource commitment and the process of acquiring new capabilities and competences may hinder short-run profitability. Therefore, research that only considers a single dimension or a narrow range of the performance construct (e.g., multiple indicators of profitability) may yield a misleading description and normative theory building (Christensen, 2006). Research that tests propositions, such as this endeavour, should include multiple performance measures. Such measures could include traditional accounting measures such as sales growth, market share, and profitability. In addition, indicators of overall performance would be useful in incorporating the firm's goals, objectives and aspiration levels (Kirchhoff, 1978), as well as other elements such as broader stakeholder satisfaction. Alternative measures of performance may compete with one another, depending on the size and type of firm and its ownership structure (Chenhall, 2003). This can be addressed by the use of the balanced scorecard (BSC) to evaluate firm performance (Kaplan and Norton, 2001). Cornerstones of the BSC include its balance of different aspects of performance, multiple stakeholder perspectives, including external organisations, and the way it encourages setting goals for measures. Innovation and learning are recognised as important by the BSC, and just as the previous chapter discussed how innovation is essentially an inter-organisational process (Tidd and Bessant, 2016), the BSC suggests that performance is of interest to and influenced by stakeholders beyond the immediate organisation.

Other nonfinancial considerations may also be important for firm performance, such as reputation, public image and goodwill, and the commitment and satisfaction of employees. Quinn and Cameron (1983) found that the criteria for evaluating firm performance and effectiveness shift as an organization evolves; therefore, those investigating the effectiveness and impact of specific organizational practices should be careful to choose the right performance criteria.

In this research, the construct of firm performance (Jaworski and Kohli, 1993) was measured subjectively, which is a common practice in research on companies and business units (Powell, 1995). In particular, overall financial performance was measured using five subjective items: profitability, sales, growth, and overall financial performance, following the recommendations of various authors (Gebauer et al., 2010; Lawrence and Lorsch, 1967; Dess, 1987; Powell, 1992). While subjective performance measures are widely accepted in organizational research, the author preferred to use financial statement data because the study's heterogeneous sample showed substantial industry variance in terms of capital structure and accounting conventions, and the manufacturing target sample showed differences in inventory valuation, depreciation, and employee salaries. (Powell, 1995). Firm performance, as the author refer to it in this research, is a subset of organizational effectiveness that covers market, operational, learning and financial outcomes. Prior empirical research looking at servitization's impact on firm performance has measured performance using market performance measures (e.g., customer satisfaction, total sales and market shares) and financial performance measures (e.g., return on sales (ROS), return on assets (ROA), general profitability and cash flow) (Gunday et al., 2011). Gebauer (2008) measured overall profitability by average return on sales (operating result before tax/sales) of the business unit over the last three years and average return on sales in comparison with the industry average. Gebauer et al. (2011) later measured firm performance by asking participants their market share and financial performance relative to competitors over a 3-year span.

The measures used in this model construct will be explained in detail in Chapter 4.

CHAPTER 4

Research Methodology

According to Faul et al. (2007), data collection in empirical studies can rely on existing data (secondary data) or independent data (primary data). In order to answer the proposed research questions and investigate the servitization processes undertaken by manufacturing companies, this empirical analysis includes the collection of both primary and secondary data.

Popper's (1972) theory of scientific explanation will be followed to achieve the research aim and objectives, and will influence the research strategy. The scientific explanation theory entails the conjecture that science per se should enhance the ability to provide explanations (rather than merely descriptions). To do this, the model of scientific explanation can be utilized to describe and systematically structure such explanations as causation, as causal claims are the main pillars of scientific explanation. Consequently, a cross-sectional quantitative research design was adopted and 'The Deductive-Nomological' (DN) model has been followed to explain the cause-effect relationship proposed in this research (Popper et al., 1973). Furthermore, the research area is organizational and managerial science, which relies on assumptions rather than deterministic rules (e.g., laws in natural science). Therefore, a deductive-statistical explanation, as suggested by Hempel (1965), has been followed.

In this explanatory research, a cross-sectional, self-administrated survey was used to collect firm-level data from the target population (Van de Ven, 2007; Wittenberg, 2001). This approach was deployed to capture the respondents' perceptions and attitudes toward the servitization phenomenon. Cook and Campbell (1979) argue that this method of inquiry (quasi-experimental cross-sectional survey) is the only one that allows the testing of statistical significance, and thus, the establishment of co-variance or correlation between the presumed causes and effects of the phenomenon.

4.1 Philosophical Standpoint

This current research approaches theory testing through empirical research. A set of testable hypotheses have been postulated, drawing on prior literature and theoretical underpinnings. As this thesis can be qualified as a scientific research endeavour, it inevitably follows a specific philosophy of science that guides the researcher's understanding of the nature of the phenomenon of interest (ontology), the means used to facilitate the acquisition of such knowledge, and how this knowledge can be understood (epistemology) (Van de Ven, 2007). The use of survey data will allow the developed hypotheses to be tested in order to derive recommendations and conclusions. According to Bryman and Bell (2003), the epistemological concerns with regard to what is or what should be considered valid acceptable knowledge in a discipline should be identified in order to choose the right research design. This thesis follows a post-positivistic epistemology, in which the researcher favours the belief that human knowledge is based not on unchallengeable foundations, but rather on human conjecture. Therefore, knowledge can be modified or withdrawn in light of further investigation. Post-positivism refines the views and beliefs of positivism, and advocates the application of the methods of the natural sciences to the study of social reality and beyond (Bryman and Bell, 2003).

Post-positivism acknowledges that the theories, hypotheses, background knowledge and values of the researcher need to be taken account of and can influence what is observed (Reichardt and Rallis, 1994). The post-positivist critical realist believes that the goal of science is to hold

steadfastly to the goal of correctly understanding reality, even though the author can never achieve that goal. Because all measurement is fallible, the post-positivist emphasizes the importance of multiple measures and observations, each of which may be subjects to different types of error. Triangulation across these multiple sources can thus be used to try to obtain a better understanding of what is happening in reality. According to post-positivism, reality does exist but can only be known imperfectly because due to the researcher's limitations. Therefore, post-positivists pursue objectivity by recognizing the possible effects of biases and understanding the structural changes that might happen (Kuhn and Hawkins, 1963). Following this research philosophy, the ontological standpoint of post-positivists is that reality exists but can only be known imperfectly and probabilistically. Therefore, the logic of scientific discovery is falsifcationism (Popper, 2005).

4.2 Questionnaire Design and Data Collection

For this thesis, different types of data were collected from two sources: perceptual data from a firm-level survey, and objective performance data from secondary sources (OSIRIS database). The researcher employed a quasi-experimental, cross-sectional, self-administrated survey to collect firm-level data from the target population (Van de Ven, 2007). Such data allows the testing of statistical significance, and thus, the establishment of covariance or correlation between the postulated causes and effects of the servitization phenomenon. Use of a survey-based mode of inquiry is expected to enable, even if restrictedly, the generalization of the study's findings to a broader context (Jick, 1979).

This data collection instrument (a questionnaire) was developed based on the prior literature and included the main measures and constructs though to drive servitization in manufacturing companies. The main reason for using a survey to collect primary data was that data could be collected from a wide range of participants cheaply and swiftly, saving time and enhancing effectiveness (Saunders, Lewis, and Thornhill, 2014). The main objective of the data collection instrument was to collect useful data to test the research hypotheses. Before the questionnaire development process and the operationalization of constructs, initial, semi-structured orientation interviews were held with

three different senior service managers from different manufacturing businesses in the UK. This was done in order to support the development of the questionnaire.

These initial interviews were followed by the operationalization and enumeration of the C-OAR-SE method (Rossiter 2002) for scale development in case the researcher could not find a measurement scale that suited the study's empirical context. The servitization construct was developed following the C-OAR-SE method. This method is used because it has total emphasis on achieving high content validity of the item(s); therefore, it fits the research objectives better than the psychometric approach, which is based on Churchill's "scale development" procedure (Rossiter, 2011). Furthermore, The C-OAR-SE procedure has no limitation as it can be applied to all types of construct, reflective and formative specially when measuring a subdimension of the construct using single items, such as beliefs and perceptions (Rossiter, 2011). (For the most recent sample of the research questionnaire, see Appendix A. After fully developing the survey, a draft version was examined by three academic staff from University of West London (UWL), Swansea University and Lancaster University, respectively, who were well oriented with the research topic. The feedback received from those academics was very positive in terms of overall questionnaire design. The author did receive some constructive feedback regarding the need for scale anchoring for the firm performance items. These items were thus anchored on a scale ranging from "Strongly Decreased" to "Strongly Increased" rather than "Very Successful" to "Not at all Successful." The servitization scale did appear to be reasonably appropriate for measuring servitization.

In January 2016, a pilot study was conducted in which the questionnaire was discussed with industrial service experts. The questionnaire was piloted in a modular manner. First, so-called 'dry-runs' were carried out to test the questionnaire using three selected manufacturing firms in the UK that were not included in the final study. The pilot study was conducted to examine the acceptance of the paper-based questionnaire, to test how comprehensible the research questionnaire was, and to highlight any ambiguity in the wording, special expressions or industry specific jargon. The dry run

feedback received was to make some minor tweaks to some aspects of the questionnaire, for instance, adding question number 11 asking if the manufacturing firm has a stand-alone service unit. This was added as an indicator of an established servitization process. Later, content validity and reliability were tested using both exploratory and confirmatory factor analysis, adding evidence for the adequacy of the questionnaire used (Churchill and Iacobucci, 2005).

The final version of the questionnaire was completed after taking into consideration various issues related to the design, layout and final implementation of the questionnaire. This was done in order to increase survey response. A cover letter was included with the final questionnaire to introduce the participants to the study objectives, explain some concepts and assure the respondent that their confidentiality would be maintained (Smyth and Williamson, 2004). Each firm identified as meeting our inclusion criteria was sent a mailing included a prepaid return envelope, a cover letter and the the questionnaire, this questionnaire packet was sent through the postal system. The letter asked the respondents to complete the questionnaire if possible or to pass it on to others potential respondents who are appropriate.

The self-administered postal survey was adopted for its efficiency in gathering firm-level data as well as for ease in coordinating and administrating the data collection process (Stevens and Loudon 2003). Purposive sampling was used to target the study population, which meant distributing the questionnaire to those subjects who met the inclusion criteria and were related to the research interests. Some of the shortcomings of postal questionnaires are that can be difficult to obtain a fully representative or diversified sample, and it can be hard to exert control over the sample; however, this technique is widely used in these types of studies (Stevens and Loudon, 2003).

In summary, to test our hypotheses, a questionnaire was drafted in English and pretested with executives and managers, who were asked to review it for readability, ambiguity, and completeness (Dillman, 2007). The questionnaire was also critiqued by three academics who were asked to review the survey items (statements) for ambiguity and clarity, and to evaluate whether the individual items

appeared to be appropriate measures of their respective constructs (DeVellis, 2003). Minor changes were made based on these pre-tests.

The questionnaire was developed in English and then back-translated into German and French by two different groups of native speakers of those languages to ensure similarity in meaning and semantic equivalence across languages (Schaffer and Riordan, 2003). The survey data was collected between February 2016 and September 2017. Following Dillman's Total Design Method (Dillman, 2007), initial mailings were followed by second mailings and follow-up phone calls if necessary. The author adopted the following two-part approach to ensure the quality of the obtained data and to achieve the best possible survey response rate. First, in the pre-screening stage, each potential participant was contacted by phone to request his/her participation in the study; this prevented the survey from being received as 'cold.' Second, three questions were introduced into the questionnaire to subjectively check the quality of the information provided by the respondents and their knowledge about the research topic (Kumar, Stern, and Anderson, 1993).

We received responses from 220 firms out of 1130 (19.5%), 20 of which were excluded due to missing data or inconsistent datasets. The data preparation concentrated on the distribution of each individual variable and construct. As suggested by Hair (1998, 2010), we looked at skewness, kurtosis and outliers. Outliers showing extreme deviation from the mean – more than 2 times the standard deviation – were removed (Hair, 1998; Hair, 2010). Further data screening for outliers, unengaged responses, and normality issues were conducted, resulted in the exclusion of another 10 respondents. We also excluded five cases where respondents had a low degree of knowledge regarding the research topic; this was done based on the added question which reflects the respondent's knowledge about the research area as mentioned above.

It was ensured that all remaining firms had available financial data. Our final data set consisted of 185 fully completed questionnaires, yielding an effective response rate of 16% (185/1130). This response rate is considered satisfactory, and is comparable to similar management studies employing

same data collection instrument (Baruch, 1999; Gebauer, Edvardsson, and Bjurko, 2010; Kumar et al., 1993; Wagner, Grosse-Ruyken, and Erhun, 2012).

4.3 Sample

The sampling for this research was done in accordance with Singleton and Straits's (2005) three-stage sampling procedure, which consists of identifying the target population, constructing the sample frame, and using a probability or non-probability sampling strategy.

The target population was identified based on the selection of servitized manufacturing firms in business-to-business (B2B) settings as the study's contextual locus, Given the globalized nature of this focus, geographic restrictions were applied to include only profit-oriented manufacturing companies from the USA and Europe plus Switzerland, following recommendations from Raddats and Kowalkowski (2014) and Wagner et al. (2012). Key informant targeting techniques (Phillips, 1981) were used to identify those involved in service business development and servitization strategy. The survey was targeted toward senior managers in the marketing, operating and service departments, as they were likely to be the most informed about strategic issues pertaining to servitization. The list of companies was mainly drawn from the OSIRIS database (www.bvdinfo.com), which is a private commercial database contains financial data, directors, contact persons, business news, the sector, etc., for more than 44,000 publicly listed companies from around the world. This database has been used in similar studies on servitization (Neely 2008; Raddats and Kowalkowski, 2014).

4.3.1 Population and Sampling Frame

following Singleton and Straits (2005), a three-stage process was deployed to pinpoint the thesis sampling design. The three stages include:

1. the identification of the target population,
2. the construction of an appropriate sampling frame,
3. the application of a probability or non-probability based sampling strategy.

4.3.1.1 Target Population

The population of interest in this thesis and its empirical context, are those manufacturing firms who are actively engaged in implementing servitization strategies for the last 3 year or more which are also the study's contextual locus, at this point it should be stated that given the globalized nature of the target population, this these is applying some filtering and inclusion strategy to be used for the OSIRIS database listing procedure. As presented in table 4-2 the author only included the following countries France, Germany, Italy, Spain, Sweden, Switzerland, United Kingdom, United States as they are considered leaders in introducing servitization in manufacturing (Neely 2008).

To further characterise the target population, author also targeted publicly listed companies with primary US Standard Industrial Classification (SIC) codes in the range of 7–32 (see also table 4-1) to cover all firms related to manufacturing resulting in 2,947 companies as this study target population.

Table 0-1: Sample industry US SIC Code distribution.

US SIC	Industry	N	%
7.	Mining of metal ores	4	2
10.	Manufacture of food products	5	3
18.	Printing and reproduction of recorded media	5	3
19.	Manufacture of coke and refined petroleum products	4	2
20.	Manufacture of chemicals and chemical products	11	6
21.	Manufacture of basic pharmaceutical products and pharmaceutical preparations	14	8
22.	Manufacture of rubber and plastic products	6	3
23.	Manufacture of other non-metallic mineral products	2	1
24.	Manufacture of basic metals	5	3
25.	Manufacture of fabricated metal products, except machinery and equipment	12	6
26.	Manufacture of computer, electronic and optical products	29	16
27.	Manufacture of electrical equipment	25	13
28.	Manufacture of machinery and equipment	36	19
29.	Manufacture of motor vehicles, trailers and semi-trailers	4	2
30.	Manufacture of other transport equipment	15	8
32.	Other manufacturing	8	4
	Total	**185**	**100**

4.3.1.2 Sampling Frame

After identifying the population of interest, the second-stage of the sampling design was introduced to identify the appropriate sampling frame. Following Singleton and Straits (2005), the sampling frame is carried out in order to successfully identify the set of all subjects from which the sample can be appropriately selected.

According to Van de Ven (2007) the

construction of the sampling frame may be achieved:

> "… by either listing all the cases in the [target] population or by developing a rule that defines membership in the population. Oftentimes it is not possible to identify all members of a target population. A census listing of all members of a target population may not exist. Instead, researchers often rely on a rule stipulating criteria for inclusion and exclusion…" (p.182)

for inclusion all companies retrieved from OSIRIS database should have their full financial data available, therefore the author also ensured that the financial data of the publicly listed firms retrieved from OSIRSIS data base are all available. This resulted of 2,105 company with full financial data.

Those manufacturing firms whose main activities included industrial services as a part of their market offering were included. Industrial service manufacturers was distinguished from pure manufacturing, their core offerings were identified by analysing the firm description and history fields from the OSIRIS database, following Neely (2008). This distinguish between servitized firms and non-servitized firms carried out examining the firm's business descriptions. Using 5 sets of terms and phrases identified through the grounded theory approach, an automated coding process was developed using Excel SEATCH function. Strings of words that identified whether firms offered specific services— e.g. IF(ISNUMBER(SEARCH("serv*",$D4)),1,0)—were developed and used to automatically code the data set. A very conservative approach to coding was applied. all companies were automatically classified as pure manufacturing firms unless there was clear evidence thy should be classified as servitized firm. As a result of the coding process, 949 not servitized firms has been

identified and hence been removed from the dataset, Appendix B contains several examples of business descriptions from the OSIRIS database. Finally, 1,156 firms were identified as servitized firms that met the inclusion criteria.

Table 0-2: Search strategy and sample identification.

Product name		Osiris	
Update number		200	
Software version		191.00	
Data update		07/02/2016 (n° 2426)	
Export date		07/02/2016	
Cut-off date		31/03	
		Step result	Search result
1.	Listed/Unlisted companies: Publicly listed companies	57,029	57,029
2.	World region/Country: France, Germany, Italy, Spain, Sweden, Switzerland, United Kingdom, United States	29,510	14,038
3.	NACE Rev. 2 (Primary codes only): 10 - Manufacture of food products, 11 - Manufacture of beverages, 12 - Manufacture of tobacco products, 13 - Manufacture of textiles, 14 - Manufacture of wearing apparel, 15 - Manufacture of leather and related products, 16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, 17 - Manufacture of paper and paper products, 18 - Printing and reproduction of recorded media, 19 - Manufacture of coke and refined petroleum products, 20 - Manufacture of chemicals and chemical products, 21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations, 22 - Manufacture of rubber and plastic products, 23 - Manufacture of other non-metallic mineral products, 24 - Manufacture of basic metals, 25 - Manufacture of fabricated metal products, except machinery and equipment, 26 - Manufacture of computer, electronic and optical products, 27 - Manufacture of electrical equipment, 28 - Manufacture of machinery and equipment nec, 29 - Manufacture of motor vehicles, trailers and semi-trailers, 30 - Manufacture of other transport equipment, 31 - Manufacture of furniture, 32 - Other manufacturing, 33 - Repair and installation of machinery and equipment, 35 - Electricity, gas, steam and air conditioning supply, 36 - Water collection, treatment and supply	36,348	4,696
4.	Profit Margin (%): All companies with a known value, Last year -3	60,941	2,947
5.	Return on Total Assets (%): All companies with a known value, Last year -3	70,414	2,878

Table 4-2 continued

6.	Total Assets: All companies with a known value, Last year -3	74,954	2,878
7.	Net Income: All companies with a known value, Last year -3	75,353	2,878
8.	Market Cap.: All companies with a known value, Last year -3	45,806	2,417
9.	Number of employees: All companies with a known value, Last year -3	38,889	2,248
10.	EBIT margin: All companies with a known value, Last year -3	58,148	2,241
11.	Operating revenue per employee: All companies with a known value, Last year -3	35,999	2,241
12.	Net assets turnover: All companies with a known value, Last year -3	64,236	2,211
13.	Fixed Assets: All companies with a known value, Last year -3	70,823	2,211
14.	Price / Book value ratio - current: min=-1, Last available year	43,026	2,105
15.	Current Portion of LT Debt: All companies with a known value, Last year -3	29,609	1,156
	Boolean search : 1 And 2 And 3 And 4 And 5 And 6 And 7 And 8 And 9 And 10 And 11 And 12 And 13 And 14 And 15		
Note: Total represent only servitized firms (949 not servitized firms been removed from the dataset)		TOTAL	1,156

In our efforts to achieve a high response rate, the author was made aware of an international industrial event specializing in Industry 4.0, which is synonymous with servitization. This global event is carried out in Hanover, Germany on an annual basis, with an exhibitor list of 6,500 companies from 70 different countries (Hanover Messes, 2017). By comparing the published participant list with our dataset, we found that 450 companies on our servitized list were also participating in the event. Following a purposive sampling technique to efficiently identify knowledgeable and reliable informants (Tongco, 2007), we attended the event, where we distributed a hard copy of the survey to potential participants (in their preferred survey language). A total of 780 questionnaires were distributed and 150 were collected manually over the course of the week-long event. The postal survey was also distributed to those from the event who stated a preference for it and who provided their contact details. The postal survey was then sent to a further 350 companies from our list obtained from OSIRSIS dataset. The total number of distributed questionnaires was 1,130.

4.3.1.3 Sampling Strategy and Minimum Sample Requirements

Purposive sampling has been used in research for many years (Campbell 1955, Godambe 1982). However, where possible, random or probability sampling is recommended as a means of informant selection because randomization reduces biases and allows the results to be extended to the entire sample population (Godambe, 1982; Smith, 1983; Tongco, 2007; Topp et al., 2004). Such research results can also be applied beyond the community being studied (Bernard, 2002; Godambe, 1982; Karmel and Jain, 1987). However, random sampling is not always feasible or efficient and in our case Given the relatively manageable size of the study's sampling frame, no particular probability-based sampling procedure was utilized. In this regard this thesis is using purposive sampling.

Data was also obtained to test the study's model and hypotheses through the key informant technique, which requires sending the survey for those respondents who are more likely to possess an overarching, boundary-spanning view of their firms' upstream and downstream activities in our case (see Kumar et al., 1993; Seidler, 1974). Due to concerns expressed in previous studies about using key informants (Phillips, 1981), we took steps to ensure that the key informants were well informed about the research topic. This was done to ensure the quality of information obtained, to maximize the response and to minimize non-response bias (Churchill and Iacobucci, 2005). First, the participants were contacted by phone to ensure that the key informant was knowledgeable about the research area. If not, he/she was asked to appoint or identify another more suitable person from the firm. Second, following the recommendation of Kumar et al. (1993), three questions were added to the questionnaire to check the quality of information provided by the participant and his/her level of knowledge. The use of a single key informant for evaluating firm performance is consistent with prior studies (Mohr and Spekman, 1994).

To determine the minimum sample size required for robust PLS-SEM, we followed the recommendations of Hair et al. (2014) and Marcoulides and Saunders (2006), In their guideline, the minimum sample size for a PLS-SEM analysis should be equal to the larger of the following. (10 times

rule): 1) 10 times the largest number of formative indicators used to measure one construct, or 2) 10 times the largest number of structural paths directed at a particular construct in the structural model. The authors also recommended, however, that researchers follow more elaborate recommendations, such as those provided by Cohen (1992), that also consider statistical power and effect sizes to determine the optimal sample size. Alternatively, researchers should run individual power analyses, using programs such as G*Power.

In this research, the maximum number of structural paths directed to the servitization construct was six. Therefore, our minimum sample size must be at least 60. However, we carried out an individual power analysis using G*Power software, with a statistical power of 0.8, an alpha of 0.05 and an effect size of 0.02, as those thresholds are widely used in similar management research (Cohen, 1992; Verma and Goodale, 1995). The power analysis yielded a minimum sample size of 114. The study ended up achieving a sample size of 185 firms, meeting this minimum requirement.

It is worth mentioning that the sample consisted of companies from diverse industries, increasing the heterogeneity of the sample (Avlonitis and Gounaris, 1997). This can lead to negative effects on the quality of research findings (Dubinsky and Ingram, 1982; Bilkey, 1987). However, cross-sectional samples showing heterogeneity are frequently used in research to enhance the generalizability of the findings (Hooley et al., 1990; Kohli and Jaworski, 1992).

4.4 The C-OAR-SE Method for Scale Development

Measurement can be defined as the process of assigning numbers or labels to variables of units of interest in order to numerically represent their conceptual properties (Singleton and Straits 2005). According to Van de Ven (2007), measurement represents a problem of conceptualization. As such, it is thought of as a process of moving from the abstract to the concrete by recasting theoretical constructs into observable variables and subsequently devising replicable procedures and valid indicators (i.e., indicators that capture the constructs' intended meaning) in order to measure said variables (Van de Ven, 2007).

In attempting to operationalize and enumerate the various theoretical constructs included in this research, we principally drew upon the methodological rationale of Rossiter's (2002) C-OAR-SE method for scale development. Devised as an acronym to describe the method's stages, C-OAR-SE stands for 'Construct definition, Object classification, Attribute classification, Rater identification, Scale formation and Enumeration.' As reported by Rossiter (2002), the method draws upon the work of McGuire (1989) on the conceptualization of constructs as well as the work of Blalock (1964), Fornell and Bookstein (1982), Cohen et al., (1990), Bollen and Lennox (1991), Law and Wong (1999) and Edwards and Bagozzi (2000) on the classification of attributes. In addition to the method's background, our use of the method for scale development was further informed by the continuing academic discourse that surrounds this relatively novel approach (e.g., Boorsboom et al., 2004; Diamantopoulos, 2005; Rossiter, 2005; Diamantopoulos et al., 2008; Bergkvist and Rossiter, 2009; Rossiter, 2011).

The C-OAR-SE method, as outlined by Rossiter (2002), is grounded in rationalism rather than empiricism. As such, it thought to be in congruence with this thesis's philosophical foundation of post-positivism. According to the method's rationale, each construct of interest may be defined in terms of a focal object (henceforth referred to as 'object,' regardless of whether that object is of a physical or perceptual nature), a dimension of judgment (referred to here as 'attribute') (McGuire, 1989) and the

judges or raters (referred to here as 'rater entities'), who confer meaning to the construct (Rossiter, 2002).

The C-OAR-SE procedure is made up of six steps according to Rossiter (2011a, p. 2):

1. construct definition;
2. object representation;
3. attribute classification;
4. rater-entity identification;
5. selection of item-type and answer scale; and
6. enumeration and scoring rule

It's important to stress that the C-OAR-SE method is considered superior to the psychometric properties approach (Rossiter, 2011). Therefore, C-OAR-SE is a radical alternative to the traditional empirically based psychometric approach, in which psychometric properties can be the Confirmatory Factor Analysis, dimensionality, reliability, and validity of the construct proposed by Churchill (1979). However, the C-OAR-SE method underscores the logical validity of the construct more than the psychometric properties, in which logical validity refers to the extent a measure represents all facets of a given construct. This approach is deemed to counter the shortcoming of psychometric approach, which sometimes can lead to erroneous acceptance – or rejection – of many of our main theories and hypotheses (Rossiter, 2011).

Under this methodological approach, six steps are advised in order to develop an appropriate construct measure. These are summarized in figure 4-1 and are expanded upon in the section 4.7.2.1 on operationalization of the servitization construct.

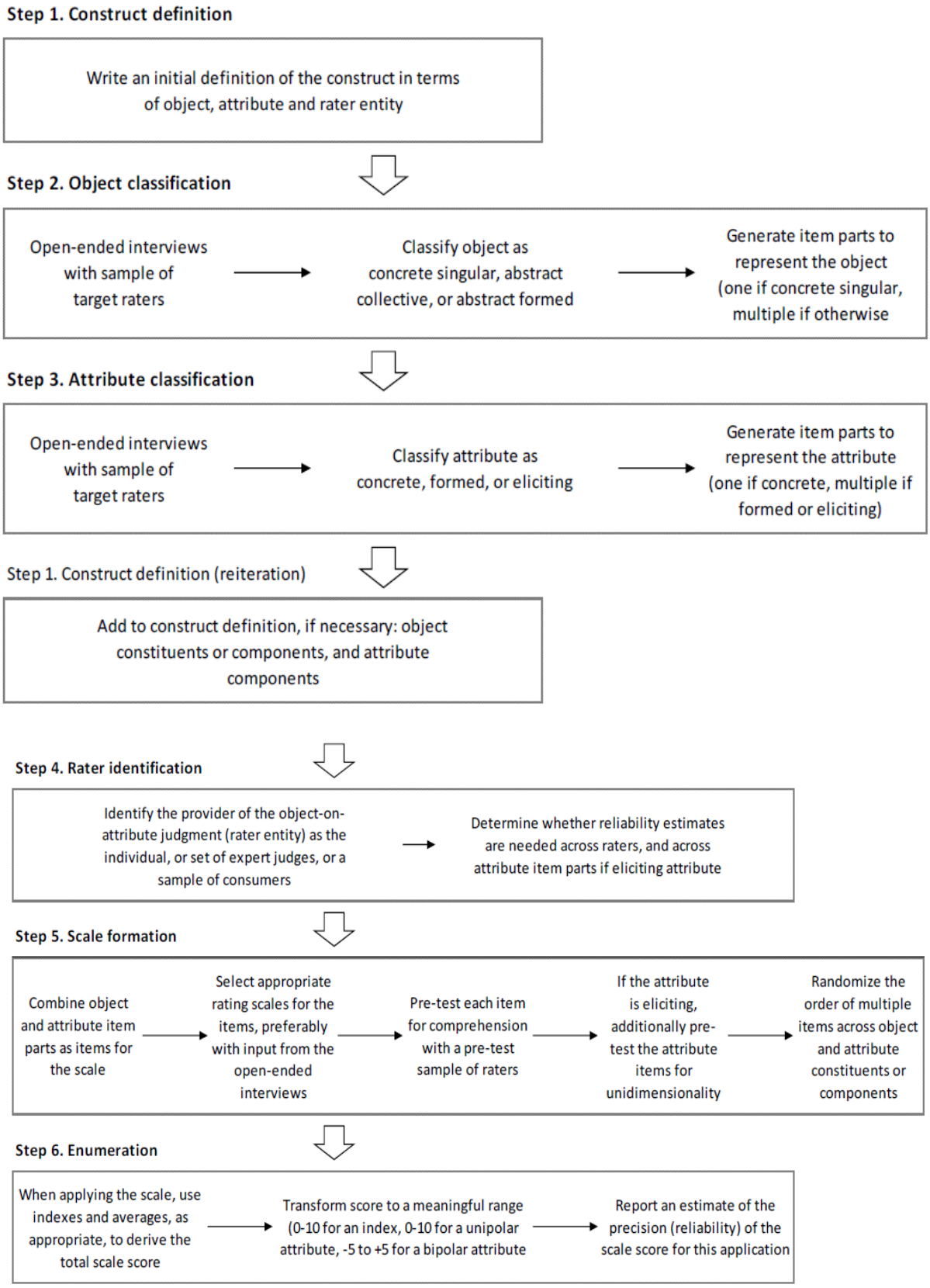

Figure 0-1: Steps in the C-OAR-SE scale development method (Adapted from Rossiter 2002).

4.5 Data Analysis Techniques

4.5.1 Overview of Major Analysis Phases

The statistical examinations used in this thesis were divided into three main stages (see figure 4.2). The first stage included exploratory and preparatory statistical analysis. This was done using factor analysis to empirically extract components of the constructs of interest and also to support the validation of a novel scale to measure servitization and the other reflective constructs presented in Section 4.7. The second and third stages consisted of structural equation modelling, which was fundamental to this research. It was divided into two major stages. The first stage of SEM analysis predicted the statistical model, taking into account both causal moderation and direct effects. The second assessed the mediating affect in the model through significance tests using bootstrapping and the indirect effect.

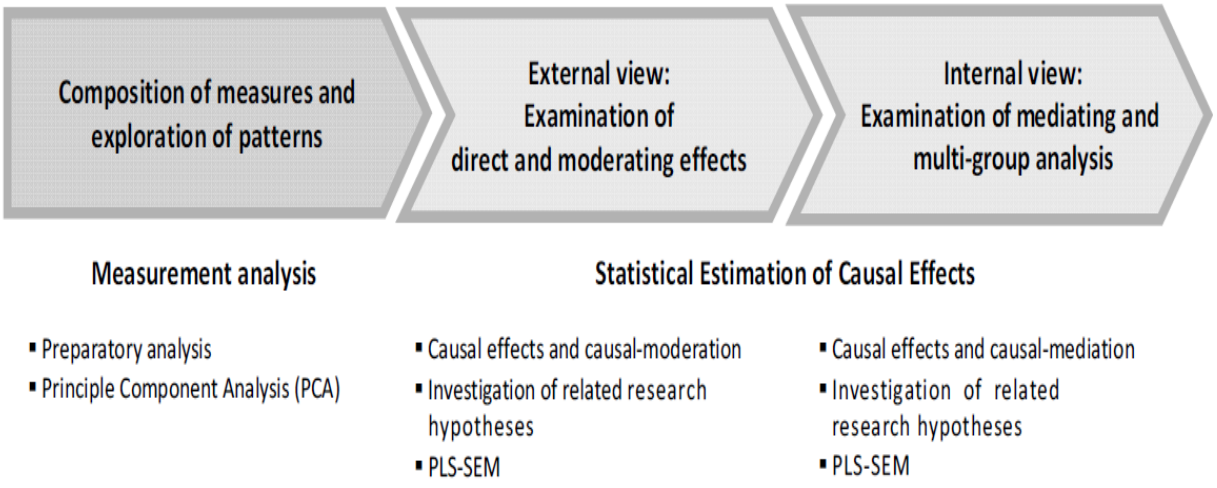

Figure 0-2: Major analyses phases (Based on: Brunswicker, 2011).

4.5.2 Structural Equation Modelling (SEM) – Basic Features and Suitability for the Research Problem

Nowadays, structural equation modelling (SEM) is a popular technique used by researchers across disciplines, especially business and the social sciences (Henseler, Hubona, and Ray, 2015). SEM can be viewed as a second-generation (2G) multivariate data analysis method (Kaplan and Haenlein, 2004). There are two types of SEM, covariance- and variance-based SEM, and it is highly important to distinguish between them. Henseler, Hubona and Ray (2015, p.2) describe the difference:

> Covariance-based SEM estimates model parameters using the empirical variance-covariance matrix, and it is the method of choice if the hypothesized model consists of one or more common factors. In contrast, variance-based SEM first creates proxies, or linear combinations of observed variables, and then estimates the model parameters using these proxies. Variance-based SEM is the method of choice if the hypothesized model contains composites.

The main goal of using SEM is to examine complex causal relationships between constructs (Hair et al., 2012). In order to determine when to use PLS-SEM instead of CB-SEM, researchers should focus on the characteristics and objectives that distinguish the two methods (Hair et al., 2012). Table 4-3 provides a comparison of the two techniques that provided a rationale for choosing variance-based SEM and its application, SEM-PLS. It also explains how SEM-PLS is appropriate for this thesis's aims and objectives.

Among variance-based SEM methods, partial least squares (PLS) path modelling is regarded as the most fully developed and general system that seeks optimal linear predictive relationships rather than causal mechanisms, thus privileging a prediction-relevance-oriented discovery process for the statistical testing of causal hypotheses (Tenenhaus et al., 2005). This makes the technique suitable for main objective of this thesis.

We used variance-based SEM software called SMARTPLS version 3. It was determined to be more appropriate for this research than other statistical software packages such AMOS, multiple regression and LISREL, in order to optimize the prediction precision (Hair et al., 2013).

In line with Hair et al. (2014), our rationale for using SEM-PLS to test the study model is as follows:

- The primary objective of applying structural modelling is prediction and explanation of target constructs, in line with our research objectives.
- The theoretical framework of this research contains both reflective and formative constructs, and PLS-SEM can easily handle reflective and formative measurement models.
- The theoretical foundation of servitization strategies and process is less developed.
- This research uses a relatively small sample size and complex models. PLS-SEM works more efficiently with small samples.

The PLS model consists of two types of models (see figure 4-3). First, the structural model (generally called the inner model in PLS-SEM) describes the relationships between latent variables (constructs). Second, the measurement models represent the relationships between constructs and their corresponding indicator variables (generally called the outer models in PLS-SEM).

Finally, the use of partial least squares (PLS) has an advantage over covariance-based SEM such as LISREL, as it requires less rigid assumptions about the randomness of the sample and the normality of the distribution of variables (Wold, 1975). Furthermore, it can accept smaller sample sizes, as each causal subsystem's sequence of paths is estimated separately (Anderson and Gerbing, 1988; Birkinshaw et al., 1995; Tsang, 2002; Wold, 1975).

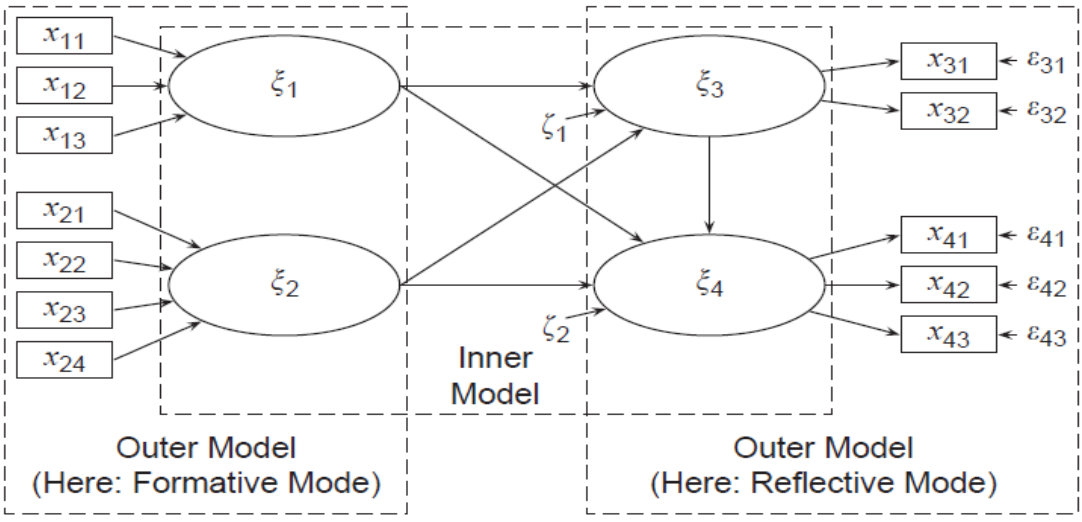

Figure 0-3: Example of a PLS path model (Source: Henseler, Sinkovics, and Ringle, 2009, p. 285).

Table 0-3: Comparison between partial least squares (PLS) and covariance-based (CB) structural equation modelling (Source: Chin and Newsted, 1999, p. 314)

Criteria	PLS	CB-SEM
Main Goal	Explanation of latent variables and/or indicator variables (prediction-oriented)	Explanation of empirical data structures (parameter-oriented)
Application	Primary exploratory examinations	Confirmatory investigations
Methodological Approach	Variance based	Covariance based
Assumptions	A distribution assumption for the indicators and assumption of independence of the observations are not necessary	The usual estimation methods are based on a multivariate normal distribution of the indicators and independent observations
Parameter estimates	Consistent if the case number and indicator number are high ("consistency at large")	Consistent
Latent Variable	Values are explicitly estimated	Values are not determined
Measurement models	Reflective and formative	Primary reflective. Formative operationalization requires special procedures.
Theory requirements	Flexible	Highly dependent
Model complexity	Highly complex models can be analysed (e.g., 100 latent variables, 1000 indicators)	Limited
Sample size	Suitable for small samples	Depending on the complexity of the model and estimation methods, a relatively large sample is required
Interdependent relationships between latent variables	Not possible in basic model	Possible
Assessment of the estimation	Heuristic, non-parametric procedures	Inferential statistical procedures
Estimate indirect and total effects (mediation)	Works through bootstrapping	Works through bootstrapping
Compare multiple effects across multiple groups	Simple	Simple
Estimate effect between latent variable	Works for underdeveloped model fit statistics	Works (with established model fit indices)
Hierarchical models (second- or third-order latent variables	Works for reflective and formative variables	Works well for reflective variables; possible for formative with "Multiple Indicator, Multiple Cause" MIMIC models

4.5.3 Construct Types in PLS-SEM Modelling

Structural equation modelling (SEM) distinguishes between two measurement models: reflective and formative (Edwards and Bagozzi, 2000). Figure 4-4 contrasts the two main construct types, which can be incorporated in any structural equation model, and descriptions are provided below.

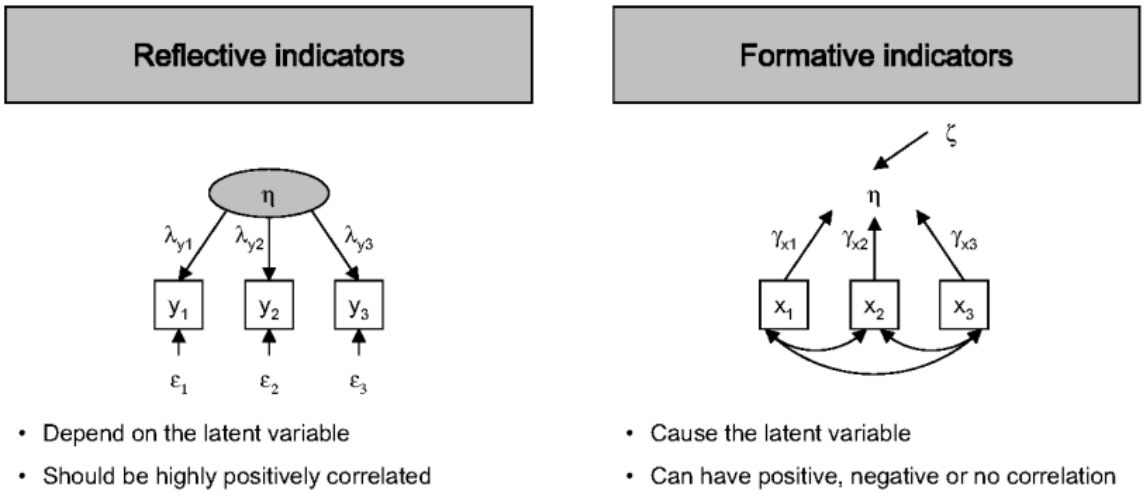

Figure 0-4: Reflective versus formative indicators (Source: Bagozzi, 2011, p. 270).

- **Reflective construct:** In a reflective construct, indicators are caused by the latent variable. Indicators usually have high inter-correlations, meaning they can be interchangeable.

- **Formative construct:** In a formative construct, the indicators cause the construct (the arrows point to the construct). Measures are not expected to correlate and they are also not interchangeable.

According to Bagozzi (2011), whether the researcher chooses to employ formative or reflective measurement, it is important to provide strong conceptual specifications of the constructs that the indicators are proposed to measure. In the current research, the only constructs that were measured formatively were the risk and firm performance constructs (see Section 4.7). The remaining model constructs were measured reflectively. This was determined based on the prior literature and

following the recommendations of Diamantopoulos and Siguaw (2006) and Edwards and Bagozzi (2000).

The above two constructs types also differ in that they are analysed using different statistical techniques and face different reporting issues following the analysis phase. For instance, with a formative construct, it is not required to test for reliability, internal consistency, or discriminant validity, but it is required to report the multicollinearity using a tolerated VIF value, as its indicators must be uncorrelated. In reflective constructs, on the other hand, it is paramount to report reliability, internal consistency, and discriminant validity.

4.5.4 Sequence of a Structural Equation Analysis

At the beginning of structural equation analysis, there is a theoretically well-founded derivation of assumptions about relationship structures in a set of observable and non-observable variables. Based on this, the specification of a structural model takes the theoretical considerations into a linear system of equation model specification. Formally, a complete structural model can be described as follows:

$$\eta = B \cdot \eta + \Gamma \cdot \xi + \zeta \quad (1)$$

$$y = \Lambda_y . \eta + \varepsilon \quad (2)$$

$$x = \Lambda_x . \xi + \delta \quad (3)$$

For the description of the model variables, see table 4-4.

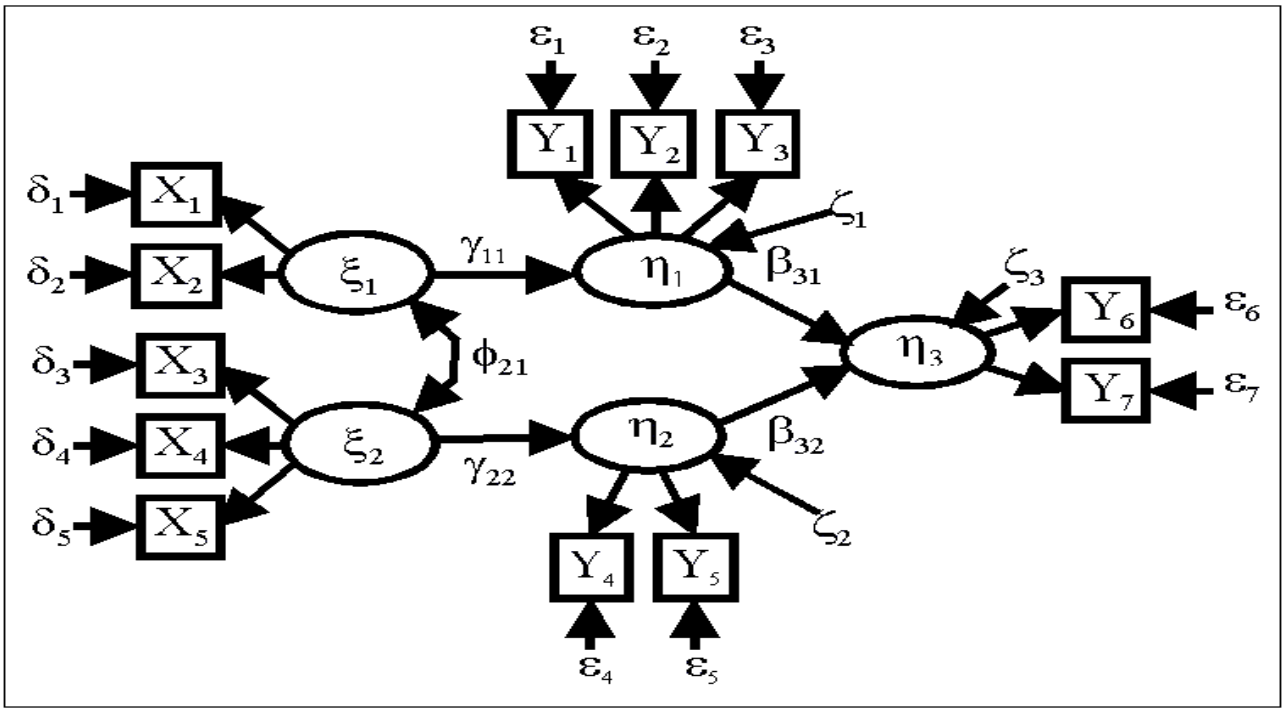

Figure 0-5: Structural model parameters (Source: Hair et al., 2014, p. 11).

Table 0-4: Nomenclature widely used in the SEM literature.

Abbreviation	Greek pronunciation	Meaning
η	Eta	Latent endogenous variable, which is explained in the model
ξ	Ksi	Latent exogenous variable, which is not explained in the model
ε	Epsilon	Error term for an indicator y
δ	Delta	Error term for an indicator X
ζ	psi	Error term for a latent endogenous variable
Γ	Gamma	matrix Γ contains the coefficients of the y's on the x's
B	Beta	coefficient matrix B models the relationship between the endogenous constructs
γ	Gamma	Denotes the relationships between the exogenous and endogenous variables.
β	Beta	Denotes the relationships between endogenous variables.
Λ	Lambda	Loadings matrix of indicators
Y	-	Indicator for a latent endogenous variable
X	-	Indicator for a latent exogenous variable

A set of Greek letters are usually used to describe the models. δ (Delta) is the measurement error of an exogenous indictor variable (X), which is a measurement variable for the exogenous latent construct ξ (psi). Similarly, Y is the measurement variable for endogenous latent construct η (Eta), with the measurement error term ε (Epsilon). The relationship between the latent constructs is described by path coefficient β (Beta). The paths from the exogenous to the endogenous variables are labelled gamma (γ). Covariance between the latent exogenous constructs is usually described with Φ (Phi).

Examining the notions (1, 2, and 3 mentioned above) once more reveals that the model integrates several multivariate approaches. Model (1) is the structural model with latent variables that cannot be measured. It expresses the hypothesized relationship between the constructs. The coefficient matrix B (with m * n Elements β_{jk}) models the relationship between the endogenous constructs. The coefficient matrix Γ (with m* n elements γ_{jk}) models the relationship between the exogenous and endogenous variables.

After building the structural model, a subsequent examination is carried out to assess the directional hypotheses manifested in the structural path of the model between the model constructs and between the constructs and their indicators.

Statistical examination is carried out to assess the following:

- Significance: How likely is it that the calculated relationships have happened accidentally?
- Direction of action: Is there a positive or negative correlation between two directly related constructs?
- Strength: Which of the significant dependencies have the strongest influence on the formation of the construct?

To ensure the quality criteria for SEM-PLS modelling, and in particular the study's SBM, are met, some tests must be performed. This incorporates testing of the measurement model, the structural model and the overall model. Table 4-5 shows the tests used for systematic evaluation of PLS-SEM results, as recommended by Hair et al. (2014). It is important to understand that these analyses are complementary and work in a supportive manner to enhance the SBM model's credibility and reliability. The quality criteria tests are divided into three phases, as follows:

- Evaluating the reflective measurement models.
- Evaluating the formative measurement models.
- Evaluating the structural model.

Table 0-5: Systematic evaluation of PLS-SEM results.

Evaluation of the Measurement Models	
Reflective Measurement Models	**Formative Measurement Models**
• Internal consistency (composite reliability) • Indicator reliability • Convergent validity (average variance extracted) • Discriminant validity	• Convergent validity • Collinearity among indicators • Significance and relevance of outer weights
Evaluation of the Structural Model	
• Coefficients of determination (R^2) • Predictive relevance (Q^2) • Size and significance of path coefficients • f^2 effect size • q^2 effect size	

Table 4-6 shows the recommendations of many scholars with regards to judging the quality criteria for PLS model. Table 4-7 also shows the cut off values for different psychometric characteristics of the variables when tested using PLS method.

Table 0-6: Sources for recommended values for assessing PLS models.

Author(s)	Criteria
Cohen (1992)	f^2
Diamantopoulos and Winklhofer (2001), Nunnally and Bernstein (1994)	Cronbach's Alpha
Fornell and Larcker (1981), Diamantopoulos and Siguaw (2006), Hair et al. (2014)	VIf, AVE
Chin (1998)	R^2, Communality
Ringle (2004), Chin (1998)	q^2, Q^2
Petter et al. (2007)	Weights, Multicollinearity
Berry and Feldman (1985)	Construct Correlations
Hair et al. (2014)	T- Values two-tailed, *β,* CR, AVE, Fornell-Larcker-criterion, factor loading

Table 0-7: General guidelines for the quality criterion in PLS-SEM model.

	Measurement Models		Structural Model	
Test criterion in PLS-SEM	**Reflective Construct**	**Formative Construct**	**Test criterion in PLS-SEM**	
Weights	Irrelevant	>0.2 or >0.1	Path Coefficient *"β"*	>0.2
Loads	> 0.7 or >0.4	Irrelevant [d]	Coefficient of Determination "R^2"	>0.3
Multicollinearity	Irrelevant	Construct Correlation <0.8 / VIF [c] <10 acceptable and 0.20 < VIF <5 best	Effect Size "f^2, q^2"	>.02
Composite reliability (CR)	>0.7	Irrelevant [d]	Predictive Relevance "Q^2"[e]	>0
Construct validity	Convergent validity/Discriminant validity	Irrelevant [d]	T- Values (2-tailed) P =.1	>1.65
Content validity	Unidimensionality [a]	Expert Validity	T- Values(2-tailed) P =.05	>1.96
Convergent validity	AVE [b] >0.5	Irrelevant [d]	T- Values(2-tailed) P =.01	>2.57
Discriminant validity	Fornell-Larcker- criterion Discriminant power >0.5	Construct Correlation <0.9	Goodness of fit (GoF) small	>0.10
Internal consistency/Internal reliability	Cronbach's Alpha >0.7	Irrelevant [d]	GoF medium	>0.25
Communality (R^2 for the construct)	>0.5	>0.5	GoF large	>0.36

a) Determined by Exploratory Factor Analysis.
b) AVE= Variances Extracted.
c) VIF = variance inflation factor.
d) Alternative calculation the psa and csv index (psa = proportion of substantive agreement, csv = substantive validity coefficient).
e) Relevant only for endogenous reflective construct.

4.6 Measures

The constructs of interest were measured either using objective secondary data from the OSIRIS database or multiple items from the questionnaire survey. The operationalization of the study's constructs was in line with the conceptual framework introduced in Chapter 3. Exploratory factor analysis was carried out for all reflective constructs in the study in order to filter out any irrelevant indictors.

Validation of the scales used in the study was carried using the standard procedures recommended in the literature (Churchill, 1979; Straub, 1989). Scale items in a related domain were pooled and subjected to factor analysis to assess their convergent and discriminant validity. Convergent validity was deemed to be satisfactory if all items showed adequately high loading on their corresponding single factor. Discriminant validity was deemed to be satisfactory when all scale items showed no significant cross-loadings on other factors. In an iterative manner, any items with high loadings on multiple factors were dropped in order to refine the study scales.

The reliability of the refined scales was also assessed using Cronbach's alpha. A minimum alpha value of 0.70 is recommended for new scales (Nunnally, 1988). The results of the reliability assessment will be presented in this section in combination with the exploratory factor analysis. We will present these results in conjunction with the operationalization of the study measures to enhance the cohesiveness of the section.

4.6.1 Measurement Model Indicators Sources

This thesis questionnaire was built using an existing validated questionnaire. Table 4-8 shows the source of the adapted questionnaire items. All constructs used to build the structural model were adopted from the literature, except for the servitization construct, which was developed by the author because no valid measurement scale was found in the servitization literature. Adaptation of previously developed scales adds reliability because they have been previously tested in different contexts (Churchill and Iacobucci, 2005).

Each construct included in the proposed model (SBM) was measured using indicators adopted from the studies listed in table 4-8 below.

Table 0-8: Contributing literature for construct definition and operationalization.

Construct	Total Number of Items	Items	Source	Journal	ABS Ranking 2015
Absorptive capacity	6	All	Kotabe et al., 2011	Journal of World Business	4
Value Co-creation	7	1 to 3	Yi and Gong, 2013	Journal of Business Research	3
		4 to 7	Grissemann and Stokburger-Sauer, 2012	Tourism Management	4
Servitization	14	All	Developed By the author	-	-
Firm Performance	14	1,6,7	Tippins and Sohi, 2003	Strategic Management Journal	4*
		2,3,4,5	Gunday et al., 2011	International Journal of Production Economics	4
		8 to 14	Wang, Liang, Zhong, Xue, and Xiao, 2012	Journal of Management Information Systems	3
Open Innovation	14	All	Mina et al., 2014	Research Policy	4
Risk	5	All	Glover and Benbasat 2010	Strategic Management Journal	4*
Service Orientation of Organisational Culture	3	All	Gebauer, 2008	Business-to-Business Marketing	2
Dynamism and Industry Clock Speed	5	1 to 3	Perrons, Matthew, and Platts, 2004	International Journal of Innovation Management	2
		4 and 5			
Control variable	3	All	Zahra and Hayton, 2008	Journal of Business Venturing	4

4.6.2 Operationalization of Dependent Variables

4.6.2.2 Servitization

The construct of servitization needed to be developed using C-OAR-SE (Rossiter, 2002) because, to our knowledge, no validated measurement scale for servitization exists in the literature. Using this method, the servitization construct operationalization took into consideration both the study's research design and the empirical context, where we are investigating the impact of servitization in manufacturing firms. First, we defined servitization in light of previous work (e.g., Antioco et al., 2008; Baines, Lightfoot, and Smart, 2011; Brax and Visintin, 2017; Fischer et al., 2010; Gebauer et al., 2010; Kowalkowski et al., 2017) to include all components relevant to the servitization construct. Then we identified the raters who would support the scale judgment. These raters consisted of academics familiar with the concept, as well as expert panel possessing good knowledge about the practice of servitization.

We defined servitization as a strategy in which manufacturing firms adapt their business models in order to sell capabilities through top management service orientation, proper investment and proper mobilization of organizational resources in order to leverage a service-centric platform business model approach. Figure 4-6 shows the servitization dimensions. In the first dimension, which is related to top management service orientation, top leaders in manufacturing firms must have a proper awareness of the opportunities that can arise from the addition of services to the current portfolio, as well as of the need for this transformation (Oliva and Kallenberg, 2003). This must be followed by identifying a starting point for assessing the current strategic asset that might help in introducing service provision. Finally, top managers in the organization must have an aligned vision of the company's servitization future (Kowalkowski et al., 2012; Gebauer, 2008). This dimension is measured using three questions, SERV_12 to SERV_14.

The second dimension is related to mobilizing the organization resources, where the servitization vision is converted into strategic goals; transformation priorities are translated into a

roadmap of initial activities (Baines et al., 2017), which requires that employees understand the benefits of the change; visible changes start to be adopted in work practice; and an evolving service culture starts to emerge (Mathieu, 2001b; Barrnet et al., 2013). In addition, investments into renewing resources and acquiring new capabilities start to materialize (Raddats et al., 2014). This dimension is measured using items SERV_4 to SERV_7.

The third dimension is related to the market offering, which encapsulates the way firms introduce servitization to their customers, what packages are available, and how the servitized offering differs from the former one. This dimension is deeply related to the service design and the contractual aspect of the market exchange. Building on the servitization topology presented in Section 2.7, a servitized market offering can consist of services that support products; services that support processes; services that support operations; services delivered through platform architecture, customer integration, or modularity in product and service design; and finally, services that help customers change their business model (Baines et al., 2017), This dimension is measured using items SERV_1, SERV_2, SERV_3, SERV_8, SERV_9, SERV_10, and SERV_11.

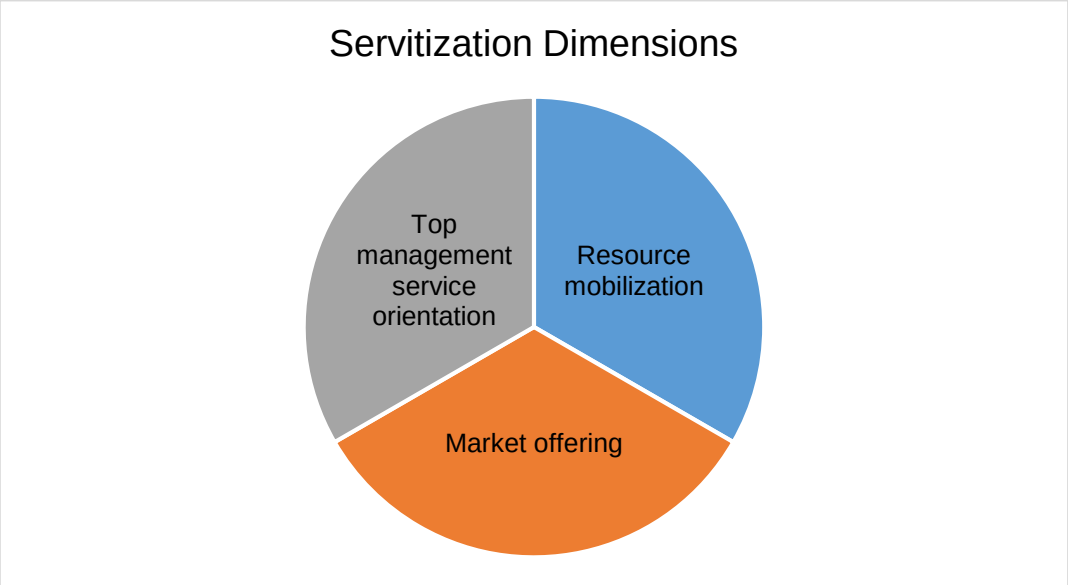

Figure 0-6: Servitization dimensions.

After the scale development, we used the qualified raters to test the servitization construct's dimensions and assess content validity prior to the data collection. This was carried out by performing interviews with five expert raters in industrial services and three academic experts. We tested the validity of the construct using the content validity index (average I-CVI). The I-CVI expresses the proportion of agreement of the raters with regard to the relevancy of each item. Scores could be between zero and one, and all dimensions exceeded the cut off value of .8 (Polit-O'Hara and Beck, 2006).

As advised by the C-OAR-SE method for testing construct reliability, the Proportional Reduction in Loss index (PRL) was applied to asses inter-rater agreement (Rust and Cooil, 1994). The PRL accounts for loss in confidence due to poor decisions by the raters, with values ranging between zero and one. Inter-rater agreement in our panel was 0.85 between five judges, resulting in a PRL of 1. This is considered suitable for ensuring the reliability of the servitization construct (Rust and Cooil, 1994).

4.6.2.3 Open Innovation

The scale adopted to measure open innovation activities was adopted from Mina et al.'s (2014) study, in which open innovation routines were grouped into four value chain activities:

- technology development (joint technology development)
- product development (joint product development)
- manufacturing (joint manufacturing and sharing of equipment)
- Commercialisation (joint bidding for new contracts and joint servicing of new markets)

Manufacturing companies were asked about their adoption of these open innovation practices with both their customers and suppliers. A six-point Likert scale ranging between 1 (Not at All) and 6 (To a Very Great Extent) was used for the assessment of the dependent variables.

In the survey, the respondents were asked to indicate the degree of importance of various activities conducted with external parties in order to accelerate innovation.

The study's measures of open innovation aim to pinpoint the importance of different partners (customers, suppliers, universities, etc.) as sources of external knowledge. The scale also contains indicators asking respondents about both the formal (contractual) and informal (non-contractual) activities they performed to facilitate open innovation. After collecting our data, we assessed the scope and the depth of the sample's engagement in open innovation practices. We added up the normalised scores for all scale items and then divided them by the total number of items. Firms that did not engage in any activity got a score of 0. Firms with higher scores were considered to be more open. The results show that a large proportion of our sample 73% reported engaging in open innovation activities, while the rest had weak engagement in OI practice.

4.6.2.4 Absorptive Capacity

The absorptive capacity measurement scale was adopted from Kotabe et al. (2011). Absorptive capacity has traditionally been measured using metrics such as R&D expenditures or the number of employees in the R&D department, both of which are considered by some as inappropriate measures (Zahra and George, 2002; Kotabe, Jiang, and Murray, 2011). In line with the prior literature (Wong, Shaw, and Sher, 1999; Zahra and George, 2002). This thesis captured absorptive capacity through variables that reflect knowledge acquisition, transformation and exploitation, using six items. The scale ranged between 1 (Strongly Disagree) and 6 (Strongly Agree).

4.6.2.5 Value Co-Creation

The measurement scale for VCC was adopted from prior studies (Yi and Gong 2013; Grissemann and Stokburger-Sauer, 2012) that drew on the SDL in the context of business-to-business service. The scale emphasises seven generic attributes of value co-creation that are key for delivering value-in-use. The scale reflects the shift from a goods-centric view to a service-centric view, which is based on the

identification and development of core competences for achieving competitive advantage through developing relationships with key economic actors in the supply chain (e.g., customers and suppliers) (Lambert et al., 2006). This construct also reflects the conceptualization of the VCC in a servitized context, encapsulating customer engagement throughout the product life cycle, customization, co-design and production, all pillars of value creation (or co-creation) in the manufacturing realm.

4.6.2.6 Firm Performance

The dependant construct firm performance was treated and operationalised as a second-order formative construct consisting of two first-order reflective constructs: financial performance and market performance (Ravichandran, Lertwongsatien and Lertwongsatien, 2005), where the measurement scale of each first-order reflective construct was adapted from previous research (Tippins and Sohi, 2003; Wang et al., 2012; Gunday et al., 2011).

To capture the financial performance variable, we used the self-evaluation of companies' financial performance. Respondents indicated on a 6-point scale (1= poor and 7= excellent) how they would rate the revenue generation, profit and market value situation of their company over the previous three years compared to their direct competitors. This was carried out following the recommendations in the literature (Dess, 1987; Eggert et al., 2011; Gebauer, Edvardsson, and Bjurko, 2010; Powell, 1995), where this construct was measured subjectively, which is a common and accepted practice in research on companies and business units (Powell, 1995). Subjective measures of firm performance have been found to be highly correlated with objective measures (Wang, Liang, Zhong, Xue, and Xiao, 2012) and have thus been used by many prior studies of firm performance (Coltman, Devinney, and Midgley, 2011; Gunday et al., 2011; Westerman et al., 2014; Zahra, 1991)

In particular, overall financial performance was measured subjectively using seven items, as such profitability, ROI, ROS, ROA, sales growth, market value, and overall financial performance. Respondents were asked to evaluate their firm’s financial performance over the past three years

compared to their direct rivals in the industry. The three-year bracket was chosen in order to minimize the influence of short-term performance variations, and it does not require that the participants to have long tenures in the targeted company (Ravichandran, Lertwongsatien and Lertwongsatien, 2005).

The rationale for explicitly asking respondents to evaluate their firm performance in comparisons to rivals was to control for differences in performance resulting from industry and strategic group effects (Hatten, Schendel, and Cooper, 1978). This approach also fit nicely within the scope of our research, as our sample included manufacturing companies from more than 13 industries. Furthermore, it is considered an indirect approach for collecting sensitive data about competitiveness and performance (e.g., Dess, 1987; Powell, 1992; Powell and Dent-Micallef, 1997; Spanos and Lioukas, 2001).

Market-based performance was measured using a seven-item scale that assessed the success of the firm in entering new markets and its speed in bringing new products and services to the market during the past three years.

Although the use of subjective financial performance measures is generally considered reliable (Dess and Robinson, 1984), we checked for the reliability of our self-reported performance data to account for any potential reporting biases. To do so, we collected data on common accounting-based measures from the OSIRIS database to objectively assess performance. The collected data was for financial years 2013, 2014, and 2015, as our sample included companies that had been undergoing the servitization transition for only 3 years. We subtracted the industry average (based on a firm's 4-digit SIC code) from each firm's measurements to control for industry influence (Agle, Mitchell, and Sonnenfeld, 1999). We then averaged 3 years of performance data to create composite firm-specific measures. Operationalization of Independent Variables

4.6.2.7 Service Orientation of Organisational Culture

The measurement scale for service orientation of corporate culture was adopted from Gebauer (2008) and drew on the existing literature (Homburg, Fassnacht, and Guenther, 2003). In this thesis, service orientation of corporate culture was measured using three items focused on the values and behaviour of service employees: in terms of ability to solve customer problems, insuring the service quality and conveying good corporate culture.

4.6.2.8 Risk

The formative construct of risk was operationalized by adopting the scale measurements from Glover and Benbasat (2010). The dimensionality of the risk construct was confirmed in prior literature (Spiekermann and Paraschiv, 2002), where the authors suggested breaking down overall risk into the attributes of operational risk, customer risk, financial risk, level of delivery risk, and overall risk. In order to assess this construct's dimensionality and reliability, the substantive validity assessment, CSV, was performed by approaching five academics who have published in the field of industrial services, operations management and/or scale development. Those academics represented 'expert opinion' holders and were selected based on their availability to collaborate with the author.

For the process of validating the risk scale, the five experts were given a list of 68 items, including the risk items and the operational definitions of the proposed construct dimensions – operational risk, customer risk, financial risk, level of delivery risk, and overall risk. The respondents were asked to assign the items to the dimension they best reflected, and were asked whether this definition reflected the meaning of the construct in question or it could be assigned to another construct. The output of this procedure was analysed using two indices of substantive validity proposed by Anderson and Gerbing (1991) which is presentedted in chapter 5.

4.6.3 Operationalization of Moderating Variables

4.6.3.1 Industry clock speed

The measurement scale for industry clock speed, as a measure of industry dynamism, was adopted from past studies (Hauschild et al., 2011; Guimaraes, 2011; Fine, 1998; Perrons, Matthew, and Platts, 2004) and was further developed based on the literature (Fine, 1999; O'Connor, 1998, Shapiro, 2006). In the scale, industry clock speed is measured by assessing the rate of new product introduction to the marketplace, the rate of change of customer preferences, changes in the firm's structure, and the pace of technology change with a specific industry. These contingent changes are measures of industry dynamism, which requires adaptation from firms. This construct was measured as an ordinal variable classifying industry dynamism as high, medium, and low.

4.6.4 Operationalization of Control Variables

Since manufacturing firm performance can be influenced by industry and firm characteristics (Zirger and Maidique, 1990), the study model also been controlled for several company-related variables (age, size) and for industry specific variables such as industry type.

4.6.4.1 Company Age

Our reason for including company age as a control variable in our analysis is that more mature manufacturing firms might be reluctant to pursue a servitization strategy. Zahra (1991) argues that older companies may be more likely to face issues such as inertia and sunk costs in ongoing operations that may hamper their ability to explore innovative strategies such as introducing service provision. In this context, and following recommendations from the literature to control for firm age (e.g., Park and Ro, 2011; Terjesen, Patel, and Covin, 2011), firm age was calculated as the natural logarithm of the number of years between the observation year and the incorporation year. The natural logarithm was used to obtain normal distribution.

4.6.4.2 Company Size

Our reason for including company size as a control variable in our analysis is that larger companies usually have resource slack that allow them to entertain and accommodate servitization strategies. Furthermore, larger firms tend to exhibit more market power to eliminate competition and build barriers to entry, which is in turn reflected in higher-than-normal financial performance, competitive advantage and increased ability to reap scale efficiencies (Hitt et al., 2002). Given these justifications, and following the recommendations in the literature to control for firm size (e.g. Ettlie, 1998; Park and Ro, 2011; Terjesen et al., 2011), the author also controlled for the effect of company size, using the natural logarithm of the number of employees as our proxy for firm size.

4.6.4.3 Industry Effect

Manufacturing firms in different industries face different competitive challenges, causing them to take different routes to pursue strategic decisions as such servitization (Dess, Ireland, and Hitt, 1990). The payoff from venturing into servitization might also vary by industry type, causing heterogeneity in firm performance. Therefore, it was paramount to include the industry type as a control variable, following the recommendations of previous studies (e.g., Huang, Kristal, and Schroeder, 2008; Rungtusanatham et al., 2005).

Industry effect was operationalized using a series of dummy variables at the 2-digit SIC level to further partial out any industry effects, with the metal ore mining industry employed as the reference group. Because industry is a categorical variable, the 16 SIC industries of interest were converted into a set of dichotomous independent variables (Tabachnick and Fidell, 2001). These 15 dichotomous variables (K-1) were entered into the regressions as dummy variables, controlling for the relevant industry.

CHAPTER 5

Primary Analysis and Results

5.1 Research Constructs Psychometric Assessment

5.1.1 Servitization Construct Psychometric Assessment

To overcome the shortcomings in the existing research and since servitization cannot be measured with only a single indicator, servitization is considered in this research as a complex phenomenon and multidimensional concept (Baines, 2009). Therefore, servitization's operationalization was represented using multiple measures (Hair et al., 2010).

EFA was utilized to examine the convergence of the measurement items for the servitization construct, confirming the validity of the three, theoretically-determined dimensions of the measurement framework (Hair et al., 2010).

The EFA was carried out using principal component factoring and the orthogonal rotation method, using and eigenvalue greater than 1 and a Varimax rotation solution for not correlated variables (Kline, 2014), Varimax was used building on our finding of the items correlation matrix in the EFA. The EFA input of 14 items of the servitization construct resulted in 12 items with loading well above .40 on their respective main factor, without significant cross loadings (<.04). The SERV_7 and SERV_9 indicators were dropped for insufficient loading (see table 5-2 and 5-3). These results were deemed satisfactory (cut-off point at 0.4), with internal consistency/reliability alpha higher than 0.7

indicating practical significance (Hair, 2010; Tabachnick and Fidell, 2001). Two items had poor loadings of < .40, indicating that they were irrelevant to their dimensions; these were excluded from the final measurement model analysis.

Table 5-1 shows the suitability of the collected data for structure detection. To obtain adequate results, all items in the servitization construct were included using a standardized form. This was carried out to enhance content validity and eliminate unnecessary multicollinearity attributed to scaling. Measure of Sampling Adequacy (MSA) showed satisfactory correlations in the data matrix. This is important to justify the use of factor analysis (Hair et al., 2014). The Bartlett test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure were used to test the adequacy of the factor analysis. KMO and the Barlett test yielded results in line with common standards (KMO=0.875; P (Barlett) = 0.000) confirmed the appropriateness of the factor analysis.

Table 0-1: KMO and Bartlett's test for servitization construct.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.875
Bartlett's Test of Sphericity	Approx. Chi-Square	721.608
	df	78
	Sig.	.000

Figure 5-1 shows the screen plot of the servitization construct indicating 3 main dimensions when the screen plot cut from the elbow. This output is also inline with the construct conceptualization. In this line graph of Eigen Values which is helpful for determining the number of factors the EFA produced after grouping the servitization indcators. The Eigen Values are plotted in descending order. The number of factors is chosen where the plot levels off (or drops) from cliff to screen.

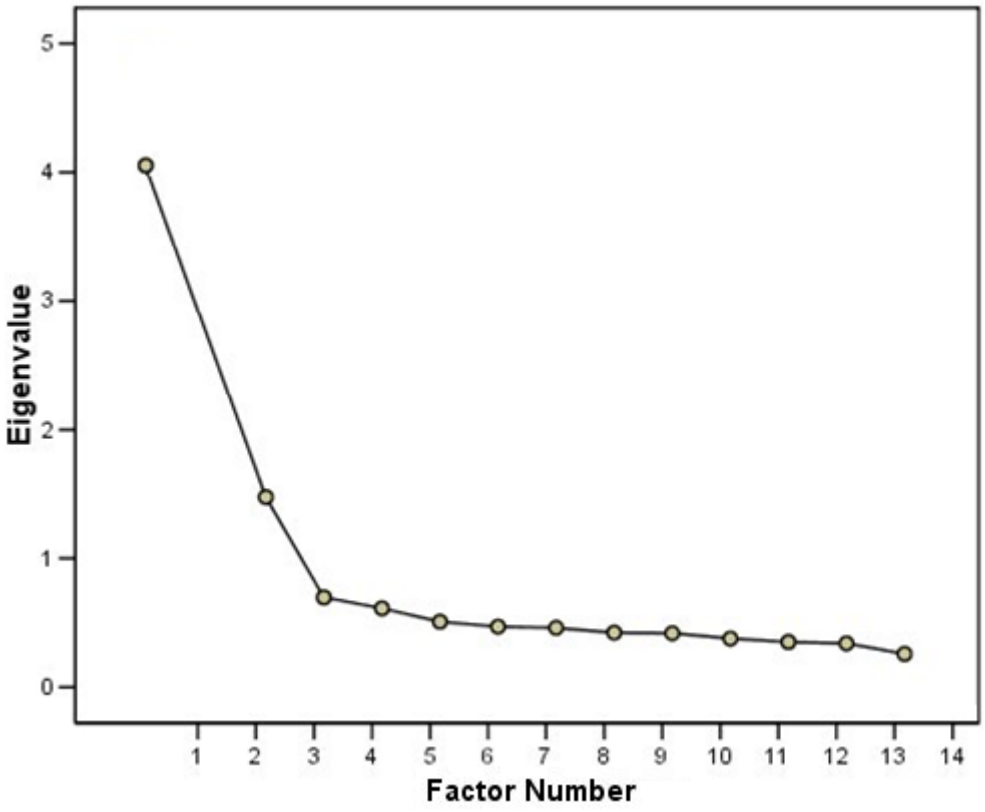

Figure 0-1: Servitization construct (EFA) screen plot.

The first stage of the EFA was carried out after standardising all variables. The un-rotated factor matrix was checked to obtain a good view of the number of factors extracted in the analysis. The results indicated that there were three factors. At a later stage of the analysis, relying on the latent root criterion to enhance the factor selection and using rotation optimisation, a total of three dimensional measurement solutions were obtained that explained 73.32% of the overall variance.

Table 5-2 presents the rotated components matrix and the factor loadings for each measurement item included in the analysis. A total of three factors were extracted, which is in line with the construct conceptualization discussion in Chapter 2. It is also evidence of the content validity of the servitization construct. The final three dimensions of the servitization construct were top management service orientation, resource mobilization, and the market offering. The developed

measurement instrument uses a seven-point scale, ranging from 1 (Extremely Disagree) to 7 (Extremely Agree) (Churchill, 1979).

Table 0-2: Servitization construct exploratory factor analysis

Rotated Component Matrix[a]			
	Component		
	1	2	3
SERV_1	.608		
SERV_2	.803		
SERV_3	.848		
SERV_4		.873	
SERV_5		.750	
SERV_6		.717	
SERV_7		.424	
SERV_8			.668
SERV_9			.382
SERV_10			.552
SERV_11			.872
SERV_12			.835
SERV_13			.822
SERV_14			.822

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
[a] Rotation converged in 6 iterations

Table 5-3 highlights the psychometric assessment of the servitization construct, as can be seen all the indicators mean value range between 4.26 and 3.45 indicating good agreement between the study subjects on the question asked with a standard deviation of a maximum of 1.30 , all factor loading where above .4 for newly developed scale and a satisfactory Cronbach's alpha of .90 enhancing the scale reliability , the ten indictors managed to explain 54% of the variance in the servitization construct, this results deemed to be satisfactory and indicate high relevance of this newly developed scale.SERV_7 and SERV_9 were dropped from the final scale for poor factor loading , meaning they don't belong to the set of indictors that sufficiently measure servitization.

Table 0-3: Quality of the operationalisation of the reflective construct of servitization (n = 185)

Construct/Indicators	Key Figures				
	Mean Value [a]	Standard Deviation (SD)	Factor Loading	**Cronbach's α (alpha)**	(Communality)[b]
Servitization				0.90	54.19% (47.85%)
Our firm has taken over some of our customers' business processes. (SERV_1)	4.26	0.73	.608		
Our firm has taken over the operational functions of our products in customers' businesses. (SERV_2)	4.12	1.04	.703		
Our service contracts related to our products are designed to share 'risk and reward' with our customers, so our customers pay for the product capabilities, outcomes and results. (SERV_3)	4.24	0.89	.748		
Our employees don't understand the benefits of building long-term relationships with our customers. (SERV_4) ®	4.24	0.94	.873		
The organization is investing in the necessary skills and capabilities to provide servitized offerings. (SERV_5)	3.69	1.10	.750		
Our business cases and key performance indicators are linked to our roadmap. (SERV_6)	4.12	1.00	.717		
Our firm continuously innovates its internal capabilities and processes to deliver new services with our products. (SER_7)	3.71	1.04	.324		
Our firm strategy is to build an industry platform to integrate suppliers and customers. (SERV_8)	3.88	1.04	.668		
Our firm offers depend on the modularity of services and products. (SERV_9)	3.76	1.09	.302		
Our firm delivers non-standardized service modules reflecting the requirements of the products we supply. (SERV_10)	4.11	1.14	.552		
We help our customers to change their business model. (SERV_11)	4.11	0.95	.772		
Our senior leaders are aligned around the strategic importance of servitization transformation. (SERV_12)	3.89	1.18	.835		
Our senior leaders are actively promoting a vision of the future that involves servitized offerings. (SERV_13)	3.45	1.30	.822		
We regularly review with the top team our progress on servitization transformation. (SERV_14)	4.04	1.05	.722		

a) The scale range between (1= Extremely Disagree to 6= Extremely Agree).
b) (Communality) =Total variances explained, calculated as the sum of the squared loadings for the construct divided by items number.
® Item reverse scored.
Indicators (SER_7) *(SER_9) have been dropped from the measurement model PLS estimate, due to insignificant loading < 0.5. The figure between the parentheses shows the "Total variances explained" before dropping (SER_7) *(SER_9).

5.1.2 Open Innovation Construct Psychometric Assessment

Table 5-4 presents the psychometric assessment of the open innovation construct, after performing an EFA it can be seen that all the indicators mean value range between 4.27 and 3.47 indicating good agreement between the study subjects on the question asked to measure the construct, these value is in upper 25% percentile with a standard deviation of a maximum of 1.23 , all factor loading where above .5 for a validated scale and a satisfactory Cronbach's alpha of .94 adding evidence to the internal consistency of the scale , indicating a closely related set of items enhancing the scale reliability , the 12 indictors managed to explain 55% of the variance in the open innovation construct, The sum of the squared factor loadings for all indicators in OI construct, also refer to as the variance in that variable accounted for by all the factors, and this is called the communality. The communality measures the percent of variance in a given variable explained by all the factors jointly and may be interpreted as the reliability of the indicator. These results deemed to be satisfactory and indicate high relevance of this scale. Two indictors (OI_2 and OI_3) were dropped due to poor factor loading in the EFA, and this elimination enhanced the scale's total variance extracted and Cronbach's alpha.

able 0-4: Quality of the operationalisation of the reflective construct of open innovation (n = 185)

Construct/Indicators	Key Figures				
	Mean Value [a]	Standard Deviation (SD)	Factor Loading	**Cronbach's α (alpha)**	(Communality)[b]
Open Innovation				0.94	55.70% (49.40%)
To what extent is your company engaging directly with lead users and early adopters? (OI_1)	3.65	1.19	0.86		
To what extent is your company participating in open source software development? (OI_2)	2.71	1.68	0.32		
To what extent is your company exchanging ideas through submission websites and idea "jams" or idea competitions? (OI_3)	2.61	1.77	0.37		
To what extent is your company participating in or setting up innovation networks/hubs with other firms, or sharing facilities with other organisations, inventors, researchers, etc.? (OI_4)	3.86	1.23	0.72		
To what extent is your company involved with joint R&D? (OI_5)	3.47	1.15	0.83		
To what extent is your company involved in joint purchasing of materials or inputs? (OI_6)	3.79	1.01	0.72		
To what extent is your company involved in joint production of goods or services? (OI_7)	3.38	1.35	0.80		
To what extent is your company involved in joint marketing/co-branding? (OI_8)	4.15	0.94	0.74		
To what extent is your company participating in research consortia? (OI_9)	3.96	1.08	0.64		
To what extent is your company involved in joint university research? (OI_10)	3.98	1.03	0.76		
To what extent is your company licensing externally developed technologies? (OI_11)	4.27	0.86	0.78		
To what extent is your company involved in outsourcing or contracting out R&D projects? (OI_12)	4.21	0.96	0.71		
To what extent is your company providing contract research to others? (OI_13)	4.15	0.94	0.74		
To what extent is your company involved in joint ventures, acquisitions and incubations? (OI_14)	3.96	1.08	0.62		

a) The scale range between (1= Not at All to 6= To a Very Great Extend).

b) (Communality) =Total variances explained, calculated as the sum of the squared loadings for the construct divided by items number.

The row highlighted by light orange colour with indicator (OI_2) * (OI_3) have been dropped from the measurement model PLS estimate, due to insignificant loading < 0.5. The figures between the parentheses shows the "Total variances explained" before dropping (OI_2) * (OI_3).

5.1.3 Absorptive Capacity Construct Psychometric Assessment

Table 5-5 highlights the psychometric characteristics of the absorptive capacity construct, as can be seen all the indicators mean value range between 4.10 and 4.01 indicating high agreement between the study subjects on the question asked with a standard deviation of a maximum of 1.10 , all factor loading where above .5 for validated scale and a satisfactory Cronbach's alpha of .91 endorsing the scale reliability , the 6 indictors managed to explain 69% of the variance in the absorptive capacity construct, this results deemed to be satisfactory and indicate high relevance of this scale.

As shown in table 5-5, all indictors achieved an appropriate factor loading, ensuring the construct's convergent validity, as well an acceptable alpha coefficient, ensuring the reliability of the construct.

Table 0-5: Quality of the operationalisation of the reflective construct of absorptive capacity (n = 185)

Construct/Indicators	Key Figures				
	Mean Value [a]	Standard Deviation (SD)	Factor Loading	**Cronbach's α (alpha)**	(Communality)[b]
Absorptive capacity				0.91	69.00%
The search for relevant information concerning our industry is everyday business in our company. (AC_1)	4.04	0.96	0.80		
We develop new product/service by using assimilated new knowledge. (AC_2)	4.10	1.00	0.85		
We develop new applications by applying assimilated new knowledge. (AC_3)	4.05	1.02	0.87		
We find alternative uses for assimilated new knowledge. (AC_4)	4.01	1.08	0.83		
We revise manufacturing/service processes based on acquired new knowledge. (AC_5)	4.01	1.10	0.80		
We introduce product innovation based on acquired new knowledge. (AC_6)	4.02	1.08	0.83		

a) The scale range between (1= Extremely Disagree to 6= Extremely Agree)
b) (Communality) =Total variances explained, calculated as the sum of the squared loadings for the construct divided by items number.

5.1.4 Value Co-Creation Construct Psychometric Assessment

Table 5-6 highlights the psychometric tests of the value co-creation construct, as can be seen all the indicators mean value range between 4.51 and 4.08 indicating good agreement between the study subjects on the question asked with a standard deviation of a maximum of 1.11 , all factor loading where above .5 for validated scale and a satisfactory Cronbach's alpha of .93 enhancing the scale reliability , the 7 indictors managed to explain 59% of the variance in the value co-creation construct, this results deemed to be satisfactory and indicate high relevance of this newly developed scale

As shown in table 5-6, all indictors achieved a high level of factor loading, with alpha coefficients > 0.7 and adequate total variance explained. The Likert scale ranged between 1 (Strongly Disagree) and 6 (Strongly Agree).

Table 0-6: Quality of the operationalisation of the reflective construct of value co-creation (n = 185)

Construct/Indicators	Key Figures				
	Mean Value [a]	Standard Deviation (SD)	Factor Loading	**Cronbach's α (alpha)**	(Communality)[b]
Value Co-creation				0.93	59.52%
Our firm tailors its product/service to our client's needs. (VCC_1)	4.42	0.89	0.85		
Our customer's comments and concerns are highly valued by our firm. (VCC_2)	4.12	0.98	0.83		
Our firm is responsive to its customer's needs. (VCC_3)	4.28	0.92	0.69		
Our firm offers a non-standardized level of service to its customers. (VCC_4)	4.08	1.11	0.66		
Our client/end users are usually involved in the process of new product/service development. (VCC_5)	4.51	0.90	0.74		
Our products/services are usually developed in light of customer/client wishes and suggestions. (VCC_6)	4.13	0.91	0.81		
In order to acquire new know-how/technology we cooperate with our customers/clients (Never/Always). (VCC_7)	4.25	0.91	0.80		

a) The scale range between (1= Extremely Disagree to 6= Extremely Agree)
b) (Communality) =Total variances explained, calculated as the sum of the squared loadings for the construct divided by items number.

5.1.5 Service Orientation of Organisational Culture Construct Psychometric Assessment

Table 5-7 highlights the psychometric assessment of the service orientation of orgnasiaional culture construct, as can be seen all the indicators mean value range between 3.88 and 3.69 indicating good agreement between the study subjects on the question asked with a standard deviation of a maximum of 1.10 , all factor loading where above .5 for validated scale and a satisfactory Cronbach's alpha of .82 indcating a satsfactiory scale reliability , the 3 indictors managed to explain 74% of the variance in the service orientation of orgnasiaional culture construct, this results deemed to be satisfactory and indicate high relevance of this pre-tested scale

As shown in table 5-7, all three indictors achieved a high factor loading, with Cronbach's α (alpha) exceeding the recommended value of 0.07.

Table 0-7: Quality of the operationalisation of the reflective construct of service orientation of organisational culture (n = 185)

Construct/Indicators	Key Figures				
	Mean Value [a]	Standard Deviation (SD)	Factor Loading	**Cronbach's α (alpha)**	(Communality)[b]
Service orientation of organisational culture				0.82	74.45%
Services are one of the core values of our corporate culture. (SC_1)	3.69	1.10	0.76		
Our employee values are round solving customer problems. (SC_2)	3.76	1.09	0.90		
Employees are aware of the importance of comprehensive and high-quality services and they act accordingly. (SC_3)	3.88	1.04	0.92		

a) The scale range between (1= Extremely Disagree to 6= Extremely Agree)
b) (Communality) =Total variances explained, calculated as the sum of the squared loadings for the construct divided by items number.

5.1.6 Industry clock speed Construct Psychometric Assessment

Table 5-8 highlights the psychometric assessment of the moderator construct industry clockspeed, as can be seen all the indicators mean value range between 2.80 and 1.32, (the scale range between 1 low to 3 high) indicating good agreement between the study subjects on the question asked with a standard deviation of a maximum of 1.28 , all factor loading where above .5 for validated scale and a satisfactory Cronbach's alpha of .90 were achieved, enhancing the scale reliability , the 3 indictors managed to explain 60% of the variance in the industry clockspeed construct, this results deemed to be satisfactory and indicate high relevance of this newly developed scale. Over all, all indicators loadings were satisfactory with an acceptable reliability alpha coefficient.

Table 0-8: Quality of the operationalisation of the reflective construct of industry clock speed (n = 185).

Construct/Indicator	Key Figures				
	Mean Value [a]	Standard Deviation (SD)	Factor Loading	**Cronbach's α (alpha)**	(Communality)[b]
Dynamism and Industry Clock Speed				0.90	60.63%
In our industry the change in customer preferences is …. (IC_1)	2.21	0.64	0.81		
The change in our competitive situation is …. (IC_2)	2.25	0.71	0.82		
In our industry the technological change is …. (IC_3)	1.32	1.28	0.76		
The change in our firm structure is …. (IC_4)	2.80	0.20	0.77		
In our industry the rate of new product/service introduction to market is …. (IC_5)	2.21	1.09	0.73		

a) The scale range between (1= Low to 3= High)
b) (Communality) =Total variances explained, calculated as the sum of the squared loadings for the construct divided by items number.

5.1.7 Firm Performance Construct Psychometric Assessment

As shown in table 5-9, the correlation between overall performance and the objective profit/revenue ratio was 0.43 ($p < 0.01$). For market value and Tobin's Q, the correlation was 0.58 ($p < 0.01$). Significant correlations were also found between the study's subjective market-based performance and sales growth (0.38; $p < 0.05$) during the same three-year period. Our observation of positive and significant correlations between subjective and objective financial performance measures indicates that the archival data matched well with the respondents' subjective evaluation (Geringer and Hebert, 1991; Powell, 1995). This adds confidence regarding the validity of our survey measure of performance.

Table 0-9: Correlations between subjective and objective performance measures.

	PER_5	PER_6	PER_2	Net Profit Margin	Tobin's Q	ROI	Market performance	Sales Growth
PER_5	1							
PER_6	.18*	1						
PER_2	.54**	-.08	1					
Net Profit Margin	.65**	.03	.43**	1				
Tobin's Q	.23	.58**	.86**	.39**	1			
ROI	.27*	.36*	.71**	.67*	.54**	1		
Market Performance	.23*	.38*	.62**	.24*	.44**	.39**	1	
Sales Growth	.21*	.33*	.66**	.19*	.28**	.32**	.38**	1

(* $p < 0.05$), (** $p < 0.01$), (*** $p < 0.001$) (2-tailed).
PER_5 = General Profitability**/ PER_6=** Market Value **/PER_2=** Overall firm performance
Note: market performance is a normalised score for its measurement index

Table 5-10 shows the factor loadings of the reflective constructs. All indicators maintained a high factor loading apart from one (PER_14), which was not included in the final set of indictors for the market performance construct. The reliability of both reflective constructs showed acceptable values (> 0.07). It noteworthy to mention that the second order formative construct of firm performance cannot be evaluated for Cronbach's α (alpha).

Table 0-10: Quality of the operationalisation of the reflective constructs of firm financial and market performance (n = 185)

Construct/Indicators	Key Figures				
	Mean Value [a]	Standard Deviation (SD)	Factor Loading	**Cronbach's α (alpha)**	(Communality)[b]
Firm Performance					54.27% (47.68%)
Firm Financial Performance				0.845	58.11%
Sales growth (PER_1)	4.05	0.99	0.80		
Return on asset (ROS) (PER_2)	3.96	0.99	0.83		
Return on sales (ROS) (PER_3)	3.85	1.19	0.79		
Return on investment (ROI) (PER_4)	4.36	0.94	0.60		
Market value (PER_5)	4.04	1.05	0.77		
General profitability (PER_6)	3.54	1.05	0.80		
Overall firm performance (PER_7)	3.40	1.29	0.76		
Firm Market Performance				0.853	60.00% (49.12%)
Entering new markets (PER_8)	4.14	2.80	0.72		
Customer satisfaction (PER_9)	4.07	0.95	0.78		
Speed to market (PER_10)	3.88	0.71	0.91		
Product/service quality (PER_11)	3.68	1.36	0.82		
Success rate for new product and service introduction (PER_12)	4.59	0.99	0.63		
Market share (PER_13)	4.44	0.51	0.72		
Percentage of new products/services in the existing product/service portfolio (PER_14)	1.50	1.20	0.26		

a) The scale range between (1= Extremely Decreased to 6= Extremely Increased).
b) (Communality) =Total variances explained, calculated as the sum of the squared loadings for the construct divided by items number.

The rows highlighted by light orange colour with indicators (PER_14), has been dropped from the measurement model PLS estimate, due to insignificant loading < 0.5. The figures between the parentheses shows the "Total variances explained" before dropping (PER_14).

5.1.8 Risk Construct Psychometric Assessment

The first of these indices was the proportion of substantive agreement, Psa, which is defined as "the proportion of respondents who assign an item to its intended construct" (Anderson and Gerbing, 1991, p. 734). The equation for this calculation is Psa = nc / N, where *nc* represents the number of people assigning an item to its posited construct and *N* represents the total number of respondents. The values for Psa can range between 0 and 1.0, with higher values indicating better substantive validity.

The second index was the substantive-validity coefficient, Csv, which represents the extent to which respondents assign an item to its posited construct more than to any other construct (Anderson and Gerbing, 1991). The formula for this index is Csv = (nc – no) / N, where *nc* and *N* are defined as with the previous index, and *no* indicates a higher number of assignments of the item to any other construct. The values for this index range from -1.0 to 1.0, with larger values reflecting higher substantive validity. A recommended threshold for the Csv index is 0.5 (Anderson and Gerbing, 1991). Once the Psa and Csv scores had been calculated for each item, they were calculated for each dimension of risk. Table 5-11 shows the results of the index calculations. The five dimensions of risk achieved an aggregated Csv of above 0.5, adding evidence for the reliability and validity of the risk measurement scale. It is also advised to test for multicollinearity between the items in a formative construct, as well as the items' weight (Hair et al., 2014). For this thesis, we assessed the related measure of collinearity by calculating the variance inflation factor (VIF). In the context of a PLS-SEM formative model, a tolerance value of 0.20 or lower and a VIF value of 5 or higher indicate a potential collinearity problem (Hair, Ringle, and Sarstedt, 2011). The results showed no collinearity issue in the risk construct, and thus no items were dropped from the scale (see table 5-11). This preserved the construct's content from a theoretical perspective. All items weights were acceptable, being above the threshold of 0.02 recommended by Hair et al. (2014).

Table 0-11: Quality of the operationalisation of the formative construct of risk (n = 185)

Construct/Indicators	Key Figures					
	Weight [a]	Mean Value	Standard Deviation (SD)	psa-Index [b]	csv- Index [b]	VIF [c]
Risk						2.249
There is a risk that the financial cost associated with servitization may outweigh the benefits. (RK_1) ®	0.34	2.84	0.97	1.0	0.9	2.068
The performance of the solution we provide may not meet our customer's expectations. (RK_2)	0.29	2.41	0.99	1.0	1.0	2.145
There is a risk that we will not be able to acquire the new capabilities needed to deliver the new solution. (RK_3) ®	0.39	2.31	0.92	1.0	0.8	1.654
There is a risk that our contract partner will be unable to fulfil contractual agreements. (RK_4) ®	0.42	2.43	0.99	0.8	0.8	1.688
The decision to implement servitization in our firm is very risky. (RK_5) ®	0.34	2.56	1.16	1.0	0.8	1.550

a) The scale range between (1= Extremely Disagree to 6= Extremely Agree).
b) psa = proportion of substantive agreement, csv = substantive validity coefficient.
c) VIF = variance inflation factor = $\frac{1}{1-R^2}$
® Item reverse scored.

psa = $\frac{nc}{N}$ Where ***nc*** is the number of respondents assigning a measure to its posited construct and ***N*** is the total number of respondents. The possible range of PSA is from 0.0 to 1.0.

csv = $\frac{nc-no}{N}$ Where ***nc*** is the number of respondents assigning a measure to its posited construct, ***no*** is the highest number of assignment of the item to any other construct, and N is the total number of respondents. The possible range of CSV is from 0.0 to 1.0.

5.2 Measurement Model Reliability and Validity

The model depicted in figure 5-3 was tested using the Smart PLS 3.27 software program and all descriptive analyses were conducted using SPSS (24). This thesis followed the recommendation of Anderson and Gerbing (1988) to take a two-stage approach when testing structural models. The first step tests the validity of the measurement model using confirmatory factor analysis (CFA) in order to assess how well the observed indicators measure the underlying latent variables (Sümer, 2003). The second step involves testing the hypothesised structural model that prescribes the relationships among the latent variables.

In order to estimate the parameters in the outer measurement model, PLS-SEM with a path weighting scheme for the inside approximation was used (Chin, 2010). This was followed by nonparametric bootstrapping (Chin, 2010; Efron, 2000) with 5,000 resamplings to calculate the standard errors of the estimates and the corresponding T-values and significance levels (Hair et al., 2013).

For measurement validation, confirmatory factor analysis was performed on the study's 8 reflective constructs and their corresponding survey items. The analysis yielded satisfactory results in terms of construct reliability, unidimensionality, convergent validity, and discriminant validity.

With regards to the reliability of the study constructs and scales, table 5-12 shows the Cronbach's alpha coefficients for the reflective constructs. The values ranged from 0.819 to 0.936, well above the threshold of 0.7, establishing the reliability of all constructs (Nunnally and Bernstein, 1994).

The construct composite reliability (CR) range was between 0.893 and 0.948, well above the cut-off value of 0.7 (Hair, 2010; Nunnally and Bernstein, 1994), supporting the unidimensionality of each construct (Hair et al., 2013; Segers, 1997). Composite reliability is considered the most robust measure of a construct's internal consistency because it prioritizes items by their reliability in estimating measurement model (Hair et al., 2011). The average variance extracted (AVE) was range

between 0.616 and 0.689, well above the cut off value of 0.5, reflecting adequate unidimensionality. Higher AVEs indicate that the observed items explain more variance than the error terms (Fornell and Larcker, 1981).

To confirm convergent validity, all the item loadings needed to be greater than the threshold of 0.40 for first and second order factors. This was the case, supporting the unidimensionality with high internal consistency (i.e., loadings >.5, $p < 0.01$) of the items under each construct (Chin, 2010).

Table 0-12: Psychometric tests criteria summary

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)	R Square	Total Variance Explained (Communality)	Communality
Absorptive Capacity	0.910	0.930	0.689	0.287	69.00%	4.13
Industry Clock Speed	0.901	0.924	0.670	-	60.63%	3.90
Open Innovation	0.936	0.948	0.725	0.259	55.70%	6.68
Firm Financial Performance	0.845	0.891	0.694	-	58.11%	5.28
Firm Market Performance	0.853	0.900	0.701	-	60.00%	6.41
Firm Performance	-	-	-	0.770	54.27%	7.28
Service Culture	0.819	0.893	0.738	-	74.45%	2.23
Servitization	0.907	0.928	0.683	0.846	54.19%	6.50
Value Co-creation	0.932	0.943	0.650	0.654	59.52%	4.16

Discriminant validity was tested using the Fornell–Larcker criterion, as shown in table 5-13, where the square root of the AVE of each construct should be higher than the construct's highest correlation with any other construct in the model (Hair et al., 2014; Fornell and Larcker, 1981). This was the case and so the discriminant validity is considered to be at a satisfactory level, meaning that the study's constructs were conceptually distinct from one another (Chin, 2010).

Table 0-13: Fornell-Larcker test for discriminant validity (n=185)

	AC	VCC	OI	IC	SERV	PER	RK	SC
Absorptive Capacity	**.830****							
Value Co-creation	.452**	**.806****						
Open Innovation	.528**	.300**	**.852****					
Industry Clock Speed	.476**	.492**	.543**	**.819****				
Servitization	.657**	.477**	.534**	.532**	**.827****			
Firm Performance	.533**	.304**	.492**	.430**	.540**	**.785****		
Risk	-.499**	-.583**	-.510**	-.539**	-.570**	-.295**	-----	
Service Culture	.309**	.327**	.305**	.204**	.544**	.487**	-.545**	**.859****

Note1: * Significant at the 0.05 level; ** significant at the 0.01 level (two-tailed test); Values shown on the diagonal and in bold are the square root of the average variance extracted (AVE) (for reflective constructs only). All values are greater than the corresponding correlations; non-bolded values are the latent variable correlations.
Note2: The Risk construct is a formative construct and therefore the square root of the variance extracted is not relevant to calculate.
Note3: Single-item control variables have been omitted from the analysis, as AVE is not relevant.

The author also carried out a collinearity assessment of the constructs by testing for multicollinearity using the variance inflation factor (VIF) with a threshold of 5 (Cohen et al., 2013). This resulted in a maximum VIF of 4.366, indicating that multicollinearity was not a serious problem in the SEM analysis (see table 5-14).

Table 0-14: Outer collinearity statistics (VIF) (n=185).

Indicator	VIF	Indicator	VIF	Indicator	VIF
AC1	2.049	**IC3**	2.278	**SERV5**	1.417
AC2	2.832	**IC4**	2.413	**SERV6**	3.183
AC3	3.269	**IC5**	2.894	**SERV8**	2.633
AC4	2.517	**VCC1**	3.970	**SERV10**	2.695
AC5	2.346	**VCC2**	2.886	**SERV11**	2.917
AC6	2.455	**VCC3**	2.959	**SERV12**	2.921
OI1	3.832	**VCC4**	3.540	**SERV13**	3.469
OI2	6.943	**VCC5**	3.578	**SERV14**	2.824
OI3	3.012	**VCC6**	2.556	**PER1**	4.650
OI4	1.828	**VCC7**	2.927	**PER2**	5.647
OI5	5.320	**RK 1**	2.068	**PER3**	2.340
OI6	2.813	**RK 2**	2.145	**PER6**	2.168
OI7	2.610	**RK 3**	1.654	**PER7**	2.595
OI8	2.722	**RK4**	1.688	**PER8**	1.741
OI9	1.932	**RK 5**	1.550	**PER11**	2.024
OI10	1.875	**SERV1**	2.209	**PER12**	1.667
OI11	2.566	**SERV2**	2.921	**PER13**	2.901
IC1	2.261	**SERV3**	3.048	**PER14**	2.691
IC2	2.646	**SERV4**	2.132	**PER15**	1.591

Following recommendation of Tenenhaus et al. (2005) to calculate the predictive power of the structural model, the author calculated the SBM model's global validity, or "goodness of fit" (GoF) using the following formula:

$$\text{GoF} = \sqrt{\varnothing\ \textbf{Communality} \times \varnothing\ \boldsymbol{R^2}\textbf{inner}}.$$

The GoF is the geometric mean of two types of R^2 value averages: the average communality, also known as the average proportion of variance explained when regressing the reflective indicators on their latent variables (Fornell and Larcker, 1981), and the R^2 inner, which is the average R^2 of the endogenous latent variables. The SBM $GoF = \sqrt{0.61 * 0.56} = 0.59$, as shown in table 5-15 the GoF is considered adequate, very large and significant, exceeding the cut-off value of 0.36 suggested by Cohen (1988) and Wetzels et al. (2009) for a large effect size.

Table 0-15: Goodness of Fit.

Goodness of Fit		
	Communality	**R-Squared**
	0.69	0.287
	0.61	-
	0.56	0.259
	0.54	0.768
	0.74	-
	0.54	0.846
	0.60	0.654
Average	0.61	0.560
GoF	**0.59**	

It noteworthy to mention that. When using PLS-SEM, it is important to recognize that the term fit has different meanings in the contexts of CB-SEM and PLS-SEM. Fit statistics for CB-SEM are derived from the discrepancy between the empirical and the model-implied (theoretical) covariance matrix, whereas PLS-SEM focuses on the discrepancy between the observed (in the case of manifest variables) or approximated (in the case of latent variables) values of the dependent variables and the values predicted by the model in question (Hair et al., 2012).

5.3 Common Method Variance Tests

A common criticism of the use of cross-sectional data is the possibility of common method bias, which can be explained as “the variance that is attributable to the measurement method rather than to the constructs the measurement represents” (Podsakoff et al., 2003, p.879). In order to reduce common method variance (CMV) in our cross-sectional self-administrated survey, the author followed the recommendations of Podsakoff et al. (2003). Firstly, the author used preventive means to control the occurrence of CMV. Different response formats were used to measure the study variables. For instance, the author used Likert scales to collect our independent and dependant variables. In addition, some of the study’s control variables were based on objective secondary data, and therefore CMV was not an issue (Craighead et al., 2011). Second, the author insured that the questionnaire was short and concise to prevent participant fatigue (Podsakoff et al., 2003). Third, our study participants were oblivious to the relationships underpinning our theoretical framework, reducing an over-justification effect, illusory correlations and halo effects (Podsakoff et al., 2003). Fourth, the author measured predictors and outcomes using different formats and scales. This measurement separation is another means for reducing response biases such as halo effects, the consistency motif, acquiescence, implicit theories and illusory correlations, all of which can result in common method variance (Podsakoff et al., 2003). Finally, the author used reverse scoring for some items in the measurement scale to counter the tendency of the respondents to agree with attitude statements regardless of their actual content (Podsakoff et al., 2003).

In addition to the aforementioned questionnaire design strategies, Harman's single-factor test was used post hoc for all of the reflective constructs (see table 5-16) to test for common method variance (Podsakoff and Organ, 1986). The results indicated that no single dominant factor was present, with the largest factor accounting for only 31.75% percent of the total variance. An eigenvalue greater than 1.0 was used as the cut-off, and there was no apparent general factor. Some researchers suggest that common method variance does not pose a serious threat to the

interpretation of results, even if the first factor accounts for as much as 50% of the total variance (Rönkkö and Ylitalo, 2011). Thus, the test results suggest that the data are satisfactorily and to a great extent free from common method variance.

Table 0-16: One-factor test for common method bias.

Total Variance Explained						
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.374	33.427	33.427	13.650	31.745	31.745
2	4.604	10.706	44.134			
3	3.366	7.828	51.961			
4	2.631	6.119	58.080			
5	2.008	4.670	62.750			
6	1.833	4.262	67.012			
7	1.128	2.623	69.635			

Extraction Method: Maximum Likelihood.
Rotation = None
Eigenvalues fixed at one

Common method variance (CMV) was also assessed using a PLS-specific technique, following recommendation of Kock (2015). A full collinearity test was performed to ensure that the VIF between the study's constructs was less than a 3.3. Collinearity statistics shows that value co-creation construct is slightly correlated with the firm performance construct and servitization, however the VIF is less than 5 which is still satisfactory (Hair et al., 2014) (see table 5-17).

Overall, our analysis does not exclude the possibility of common method variance. However, the author can presume that the study results were not severely affected by the existence of any CMV, and therefore CMV is unlikely to have biased the study results.

Table 0-17: Inner VIF values.

	Absorptive Capacity	Firm Performance	Servitization	Value Co-creation
Absorptive Capacity		2.963	2.822	1.404
Company Age		1.123		
Industry Clock Speed		2.193		
Industry		1.081		
Moderating Effect Industry Clock Speed		1.110		
Open Innovation	1.000	1.814	1.804	1.404
Risk			2.249	
Service Culture			2.415	
Servitization		3.289		
Company Size		1.135		
Value Co-creation		4.366	3.855	

Table 5-18 summarizes the descriptive statistics and intercorrelations among the study variables. As illustrated in tables 5-19 to 5-25, the CFA results validate the assumption that this thesis's measures of psychometric properties were acceptable and adequate for hypothesis testing (Bagozzi and Yi, 1988). Further, it is safe to argue that there are no grounds to assume the unsuitability of the chosen method.

Table 0-18: Means, standard deviations and intercorrelations among the study's variables (N=185)

		Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12
1	**Absorptive Capacity**	4.04	0.87	1.											
2	**Value Co-creation**	4.19	0.72	.452**	1.										
3	**Open Innovation**	3.64	1	.528**	.300**	1.									
4	**Industry Clock Speed**	3.8	0.9	.476**	.492**	.543**	1.								
5	**Servitization**	4	0.8	.657**	.477**	.534**	.532**	1.							
6	**Financial Performance**	3.88	0.71	.533**	.304**	.492**	.430**	.540**	1.						
7	**Risk**	2.42	0.79	-.499**	-.583**	-.510**	-.539**	-.570**	-.295**	1.					
8	**Service Culture**	3.77	0.92	.309**	.327**	.305**	.204**	.544**	.487**	-.545**	1.				
9	**Size (LN employee)***	10	11	-.03	.00	.11	-.07	-.11	-.12	.03	-.07	1.			
10	**Company Age (LN)***	2.9	3.4	-.03	-.07	-.08	-.04	-.03	-.06	-.02	-.09	.01	1.		
11	**Industry**	0.08	0.09	-.01	-.04	-.07	-.05	-.03	-.06	.03	-.05	-.09	-.06	1.	
12	**Market Performance**	4.02	.81	.423**	.321**	.001	.391**	.450**	.523**	-.321**	.300**	-.01**	-.080**	-020**	1

* Log transformed to reduce skewness.
**$p < 0.01$ (2-tailed).

Table 0-19: Key figures for the reflective construct of servitization operationalised in the SBM model (n = 185)

Construct/Indicators	Key Figures					
	Load	Mean	Standard Error	T- Value [a]***	CR [b]	AVE [c]
Servitization					0.93	0.68
Our firm has taken over some of our customers' business processes. (SERV_1)	0.789	0.788	0.030	26.063		
Our firm has taken over the operational functions of our products in customers' businesses. (SERV_2)	0.854	0.855	0.016	53.557		
Our service contracts related to our products are designed to share 'risk and reward' with our customers, so our customers pay for the product's capabilities, outcomes and results. (SERV_3)	0.869	0.870	0.024	36.464		
Our employees do not understand the benefits of building long-term relationships with our customers through servitization. (SERV _4) ®	0.760	0.762	0.052	14.563		
The organization is investing in the necessary skills and capabilities to provide servitized offerings. (SERV_5)	0.848	0.847	0.021	39.987		
Our business cases and key performance indicators are linked to our roadmap. (SERV_6)	0.834	0.833	0.021	40.055		
Our firm strategy is to build an industry platform to integrate suppliers and customers. (SERV_8)	0.789	0.788	0.030	26.063		
Our firm delivers non-standardized service modules that reflect the requirements of the products we supply. (SERV_10)	0.854	0.855	0.016	53.557		
We help our customers to change their business model. (SERV_11)	0.808	0.807	0.030	26.990		
Our senior leaders are aligned around the strategic importance of servitization transformation. (SERV_12)	0.807	0.805	0.028	29.151		
Our senior leaders are actively promoting a vision of the future that involves servitized offerings. (SERV_13)	0.878	0.877	0.030	22.880		
We regularly review with the top management team our progress on servitization transformation. (SERV_14)	0.77	0.766	0.028	19.251		

(a) (* $p < 0.05$), (** $p < 0.01$), (*** $p < 0.001$) and NS stand for not significant (this significance level is for two tailed t- test performed in the bootstrapping with 185 case, 5000 samples and confidence intervals for 10% probability of error ($\alpha = 0.10$).
(b) CR= Composite reliability.
(c) AVE= Average Variances extracted.

Table 0-20: Key figures for the reflective constructs of absorptive capacity and industry clock speed operationalised in the SBM model (n = 185)

Construct/Indicators	Key Figures					
	Load	Mean	Standard Error	T- Value [a***]	CR [b]	AVE [c]
Absorptive capacity					0.93	0.69
The search for relevant information concerning our industry is everyday business in our company. (AC_1)	0.800	0.799	0.034	23.626		
We develop new product/service by using assimilated new knowledge. (AC_2)	0.853	0.853	0.020	43.600		
We develop new applications by applying assimilated new knowledge. (AC_3)	0.870	0.869	0.021	40.914		
We find alternative uses for assimilated new knowledge. (AC_4)	0.824	0.823	0.029	28.115		
We revise manufacturing/service processes based on acquired new knowledge. (AC_5)	0.803	0.803	0.034	23.303		
We introduce product innovation based on acquired new knowledge. (AC_6)	0.828	0.827	0.033	25.271		
Construct/Indicators	Key Figures					
	Load	Mean	Standard Error	T- Value [a***]	CR [b]	AVE [c]
Dynamism and Industry Clock Speed					0.92	0.67
In our industry the change in customer preferences is …. (IC_1)	0.735	0.732	0.048	15.270		
The change in our competitive situation is …. (IC_2)	0.822	0.819	0.033	24.647		
In our industry the technological change is …. (IC_3)	0.812	0.811	0.030	26.795		
The change in our firm structure is …. (IC_4)	0.844	0.843	0.025	34.350		
In our industry the rate of new product/service introduction to market is …. (IC_5)	0.883	0.883	0.016	56.511		

(a) (* $p < 0.05$), (** $p < 0.01$), (*** $p < 0.001$) and NS stand for not significant (this significance level is for two tailed t- test performed in the bootstrapping with 185 case, 5000 samples and confidence intervals for 10% probability of error ($\alpha = 0.10$).

(b) CR= Composite reliability.

(c) AVE= Average Variances extracted.

Table 0-21: Key figures for the reflective construct of value co-creation operationalised in the SBM model (n = 185)

Construct/Indicators	Key Figures					
	Load	Mean	Standard Error	T- Value [a***]	CR [b]	AVE [c]
Value Co-creation					0.93	0.65
Our firm tailors its product/service to our client's needs. (VCC_1)	0.850	0.850	0.021	39.832		
Our customers' comments and concerns are highly valued by our firm. (VCC_2)	0.782	0.782	0.030	25.659		
Our firm is responsive to the customer's needs. (VCC_3)	0.814	0.813	0.027	29.633		
Our firm offers a non-standardized level of service to the customer. (VCC_4)	0.844	0.843	0.021	39.456		
Our clients/end users are usually involved in the process of new product/service development. (VCC_5)	0.827	0.826	0.023	36.017		
Our products/services are usually developed in light of customer/client wishes and suggestions. (VCC_6)	0.704	0.703	0.047	14.867		
In order to acquire new know-how/technology we cooperate with our customers/clients (Never/Always). (VCC_7)	0.803	0.802	0.029	27.875		

(a) (* p < 0.05), (** p < 0.01), (*** p < 0.001) and NS stand for not significant (this significance level is for two tailed t- test performed in the bootstrapping with 185 case, 5000 samples and confidence intervals for 10% probability of error (α= 0.10).

(b) CR= Composite reliability.

(c) AVE= Average Variances extracted.

Table 0-22: Key figures for the reflective construct of open innovation operationalised in the SBM model (n = 185)

Construct/Indicators	Key Figures					
	Load	Mean	Standard Error	T- Value [a***]	CR [b]	AVE [c]
Open Innovation					0.94	0.73
To what extent is your company engaging directly with lead users and early adopters. (OI_1)	0.859	0.858	0.021	41.467		
To what extent is your company participating in or setting up innovation networks/hubs with other firms, such as sharing facilities with other organisations, inventors, researchers, etc. (OI_4)	0.911	0.910	0.014	63.102		
To what extent is your company involved with joint R&D. (OI_5)	0.865	0.865	0.022	39.430		
To what extent is your company involved in joint purchasing of materials or inputs. (OI_6)	0.732	0.729	0.044	16.811		
To what extent is your company involved in joint production of goods or services. (OI_7)	0.894	0.892	0.020	45.454		
To what extent is your company involved in joint marketing/co-branding. (OI_8)	0.837	0.834	0.032	26.310		
To what extent is your company involved in joint university research. (OI_10)	0.852	0.852	0.019	45.085		
To what extent is your company licensing externally developed technologies. (OI_11)	0.859	0.858	0.021	41.467		
To what extent is your company involved in outsourcing or contracting out R&D projects. (OI_12)	0.785	0.774	0.062	12.742		
To what extent is your company providing contract research to others. (OI_13)	0.803	0.790	0.049	16.342		
To what extent is your company involved in joint ventures, acquisitions and incubations. (OI_14)	0.793	0.784	0.058	13.694		

(a) (* $p < 0.05$), (** $p < 0.01$), (*** $p < 0.001$) and NS stand for not significant (this significance level is for two tailed t- test performed in the bootstrapping with 185 case, 5000 samples and confidence intervals for 10% probability of error ($\alpha = 0.10$).

(b) CR= Composite reliability.

(c) AVE= Average Variances extracted.

Table 0-23: Key figures for the reflective construct of service orientation of organisational culture operationalized in the SBM model (n = 185)

Construct/Indicators	Key Figures					
	Load	Mean	Standard Error	T- Value [a***]	CR [b]	AVE [c]
Service orientation of organisation culture					0.89	0.74
Services are one of the core values of our corporate culture. (SC_1)	0.755	0.755	0.032	23.605		
Our employee values are centred on solving customer problems. (SC_2)	0.900	0.900	0.020	45.465		
Employees are aware of the importance of comprehensive and high-quality services and they act accordingly. (SC_3)	0.913	0.913	0.013	71.344		

(a) (* p < 0.05), (** p < 0.01), (*** p < 0.001) and NS stand for not significant (this significance level is for two tailed t- test performed in the bootstrapping with 185 case, 5000 samples and confidence intervals for 10% probability of error (α= 0.10).
(b) CR= Composite reliability.
(c) AVE= Average Variances extracted.

Table 0-24: Key figures for the formative construct of risk operationalised in the SBM model (n = 185)

Construct/Indicators	Key Figures			
	Weigh t	Mean	Standard Error	T- Value [a***]
Risk				
There is a risk that the financial costs associated with servitization may outweigh the benefits. (RK_1) ®	0.336	0.336	0.119	2.811
The performance of the solution we provide may not meet our customers' expectations. (RK_2)	0.341	0.340	0.115	5.710
There is a risk that we will not be able to acquire the new capabilities needed to deliver the new solution. (RK_3) ®	0.395	0.394	0.103	11.786
There is a risk that our contract partner will be unable to fulfil the contractual agreement. (RK_4) ®	0.291	0.294	0.118	2.467
The decision to implement servitization in our firm is very risky. (RK_5) ®	0.388	0.381	0.079	4.936

(a) (* p < 0.05), (** p < 0.01), (*** p < 0.001) and NS stand for not significant (this significance level is for two tailed t- test performed in the bootstrapping with 185 case, 5000 samples and confidence intervals for 10% probability of error (α= 0.10).
® Item reverse scored.

Table 0-25: Key figures for the reflective constructs of firm financial/market performance operationalised in the SBM model (n = 185)

Construct/Indicators	Key Figures					
Firm performance	Load	Mean	Standard Error	T- Value [a***]	CR [b]	AVE [c]
Firm Financial performance					0.89	0.69
Sales growth (PER_1)	0.834	0.833	0.025	33.351		
Return on asset (ROS) (PER_2)	0.798	0.797	0.024	33.093		
Return on sales (ROS) (PER_3)	0.858	0.857	0.017	50.860		
Return on investment (ROI) (PER_4)	0.787	0.787	0.034	22.826		
Market value (PER_6)	0.743	0.742	0.040	18.677		
General profitability (PER_7)	0.790	0.790	0.026	30.859		
Firm Market performance					0.90	0.70
Entering new markets (PER_8)	0.679	0.679	0.043	15.812		
Customer satisfaction (PER_9)	0.781	0.780	0.009	19.157		
Speed to market (PER_10)	0.824	0.813	0.008	22.324		
Product/service quality (PER_11)	0.864	0.843	0.007	25.772		
Success rate for new product and service introduction (PER_12)	0.807	0.826	0.009	16.443		
Market share (PER_13)	0.724	0.703	0.010	13.415		

(a) (* $p < 0.05$), (** $p < 0.01$), (*** $p < 0.001$) and NS stand for not significant (this significance level is for two tailed t- test performed in the bootstrapping with 185 case, 5000 samples and confidence intervals for 10% probability of error ($\alpha = 0.10$).

(b) CR= Composite reliability.

(c) AVE= Average Variances extracted.

5.4 Descriptive Data Analysis

5.4.1 Sample

Tables 5-26 and 5-27 provide a detailed breakdown of the sample and respondents. To enhance the sample, the author also followed Neely's (2013) recommendation and targeted companies in the countries where there is high number of manufacturing firms undergoing the servitization transition (USA, UK, Germany, France, Italy, Spain, Sweden, and Switzerland). Approximately 27% of respondents were from Germany, 17% were from the United Kingdom; 16% were from the USA, 10% were from Spain, 10% were from France, 8% were from Italy, 6% were from Sweden and 6% were from Switzerland. All of those countries are considered leaders in the servitization and digitalization transition (Neely, 2013).

Of the key informants, 48% were service managers, 27% were marketing managers and 25% were operation managers. The respondents had an average of 8 (std. dev. = 3.43) years of employment with their firm, indicating an adequate amount of experience and knowledge, with 86% and 14% stating that they had a high or moderate level of knowledge, respectively, about the research area. These respondents were the most likely to possess an overarching, boundary-spanning view of their firm. All respondent firms indicated that they had been introducing services in their market offering for more than three years, and that they had a standalone service unit. Of the firms, 81% had a service share of totals revenue of between 20-30%, 15% had more than 30%, and 4% of firms had service revenues of less than 20% of total revenue. These results indicate a strong service orientation in the majority of our sample. This is in line with Fang et al.'s (2008) suggestion of 20% as the critical mass required to see substantial returns from service provision. The sample consisted of well-established manufacturing firms, averaging 18.3 (SD = 31) years in age. The firms had an average annual sales of USD 15 billion (SD= USD 25 billion), an average of 36,187 (SD = 57,008) employees, and an average return on equity (ROE) of 11 (SD = 3) percent. Finally, the study sample had an average of 5 (SD= 16) percent growth in revenues over three years.

Table 0-26: Sample demographics.

Country	N	%
Germany	50	27
United Kingdom	32	17
USA	30	16
Spain	18	10
France	18	10
Italy	15	8
Sweden	11	6
Switzerland (Not EU)	11	6
Total	**185**	**100**
Respondent job title		
Service manager	89	48
Marketing manager	50	27
Operation manager	46	25
Total	**185**	**100**
Service share of total revenue		
Less than 20%	5	3
Between 20-30%	139	75
More than 30%	41	22
Total	**185**	**100**

Table 0-27: Descriptive statistics of survey respondents (n=185).

		Frequency	
Attributes	**Distribution**	**Absolute**	**Percentage**
Gender	Male	129	69.73%
	Female	56	30.27%
Years introducing services	>1	0	0.00%
	Between 1-3	15	8.10%
	>3	170	91.9%
Respondent in the top management	Yes	13	7.10%
	No	172	92.90%
Respondent working experience	0-2 years	20	10.81%
	2-5 years	5	2.70%
	5-10 years	5	2.70%
	10-15 years	98	52.97%
	More than 15 years	57	30.81%

(**Continuation of Table 5-27**)

		Frequency	
Attributes	**Distribution**	**Absolute**	**Percentage**
Years in your current position	0-2 years	9	4.86%
	2-5 years	6	3.24%
	5-10 years	45	24.32%
	10-15 years	122	65.94%
	More than 15 years	3	1.62%
Highest level of education	High School Education	0	0.00%
	Bachelor's Degree	144	77.84%
	Master's Degree	30	16.22%
	Professional Degree	6	3.24%
	Doctorate Degree	3	1.62%
	Others:	2	1.08%
Annual sales (Turnover in Millions £)	Less than 2	0	0.00%
	Between 2 and 10	0	0.00%
	Between 10 and 50	0	0.00%
	More than 50	185	100%
Standalone service unit	Yes	183	98.91%
	No	2	1.08%
Services can be purchased separately	Yes	14	7.57%
	No	171	92.43%
Company age	Between 0-5	0	0.00%
	Between 6 and 9	0	0.00%
	More than 10	185	100.00%
Respondent knowledge about research area	Low knowledge[a]	0	0.00%
	Moderate knowledge	25	13.51%
	High knowledge	160	86.49%
Does respondent participate in implementing servitization strategies?	Yes	163	88.11%
	No	22	11.89%

a) **Note** five subjects have been excluded from the dataset for low knowledge about the research area.

5.4.2 Non-Response Bias

We also verified that our results we not subject to response bias. First, we used the chi-squared ($\chi 2$) statistical test to examine where there was a significant association between the firm's industry and response status (responded vs. did not respond); this yielded a non-significant result ($p > .05$). Second, we carried out multivariate analysis of variance (MANOVA) (see table 5-28) to compare responding and non-responding firms in terms of ROE, size (number of staff), revenue and assets. The results showed no significant differences between the two groups for any of the measures ($p > .05$).

Table 0-28: Non-response bias testing using MANOVA

Multivariate Tests							
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
respondent and non-respondent	Pillai's Trace	.006	.879[b]	4.000	386.000	.544	.006
	Wilks' Lambda	.724	.879[b]	4.000	386.000	.544	.006
	Hotelling's Trace	.006	.879[b]	4.000	386.000	.544	.006
	Roy's Largest Root	.006	.879[b]	4.000	386.000	.544	.006

Design: respondent and non-respondent
Exact statistic
Computed using alpha = .05
Note: This test compares the two groups in terms of their assets (US millions), sales, size (overall number of employees), ROE, and revenue growth.

Finally, following the recommendation of Armstrong and Overton (1977), t-tests were employed to test early and late-returned questionnaires (see table 5-29). We grouped respondents into three waves: 1) those who responded within the first 8 weeks, 2) those who responded in the ninth week or later, and 3) those who responded during the industrial event. No statistically significant differences were found between early and late respondents ($p < .05$). Finally, we compared the three groups of respondents based on their replies to the questionnaire items, and the analysis showed a significant difference ($p < .05$) for only 4% of the items. All in all, the results indicate no evidence of response bias in our sample.

Table 0-29: T-tests comparing early and late responders to check for non-response bias.

Independent Samples Test					
	t-test for Equality of Means				
Variable	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Industry	-.953	183.	.342	-.56	.587
	-.967	178.035	.335	-.56	.579
Company Age	-.866	183.	.388	-.029	.034
	-.898	182.999	.370	-.029	.032
Size (number of	.514	183.	.608	.026	.051
employees)	.508	162.541	.612	.026	.052
Net Profit Margin	-.254	183.	.800	-.267	1.051
	-.241	131.001	.81	-.267	1.106
Absorptive Capacity	-.811	183.	.418	-.104	.128
	-.814	172.16	.417	-.104	.128
Open Innovation	-.614	183.	.54	-.091	.148
	-.623	177.561	.534	-.091	.146
Servitization	-.672	183.	.502	-.08	.119
	-.677	174.555	.499	-.08	.118
Firm Performance	-.848	183.	.398	-.09	.106
	-.854	174.266	.394	-.09	.105
Risk	.54	183.	.59	.063	.117
	.542	172.682	.588	.063	.117
Service Culture	-.858	183.	.392	-.118	.137
	-.864	174.085	.389	-.118	.136
Value Co-creation	-.88	183.	.38	-.094	.107
	-.888	175.41	.376	-.094	.106

In order to examine inter-rater reliability, we compared the data collected from the three respondent groups (service managers, marketing managers, and operations managers). We analysed the simple correlations between the three groups on the variables (Items) tested, yielding an average simple correlation of 0.75. This is a moderate and significant correlation coefficient, indicating inter-rater consensus on the study measures (see table 5-30).

Table 0-30: Correlations between respondent groups on constructs to check for inter-rater reliability

Construct	AC_ Operation Manager	AC_ Marketing Manager
AC_ Service Manager	0.70**	0.63**
AC_ Marketing Manager	0.70**	1
	VCC_ Operation Manager	VCC_ Marketing Manager
VCC_ Service Manager	0.69**	0.66**
VCC_ Marketing Manager	0.77**	1
	OI_ Operation Manager	OI_ Marketing Manager
OI_ Service Manager	0.57**	0.79**
OI_ Marketing Manager	0.72**	1
	Serv_ Operation Manager	Serv_ Marketing Manager
Serv_ Service Manager	0.68**	0.74**
Serv_ Marketing Manager	0.59**	1
	Perf_ Operation Manager	Perf_ Marketing Manager
Perf_ Service Manager	0.72**	0.75**
Perf_ Marketing Manager	0.78**	1
	Rk _ Operation Manager	Rk _ Marketing Manager
Risk_ Service Manager	0.74**	0.75**
Risk _ Marketing Manager	0.73**	1
	SC_ Operation Manager	SC_ Marketing Manager
SC_ Service Manager	0.56**	0.77**
SC_ Marketing Manager	0.66**	1

**. Correlation is significant at the 0.01 level (2-tailed).

5.5 Testing the Research Models

5.5.1 Servitization Basic Model

This thesis used structural equation modelling (SEM) to test the research hypotheses. Smart PLS 3.27 software was used to estimate the study's structural model. The resulting structural model led to the following findings.

Table 5-33 shows the degree to which the research hypotheses were confirmed by the findings. H1 postulated that value co-creation positively influences servitization, and the path between value co-creation and servitization was significant and positive, with a medium effect size (β = 0.31, t = 3.08, f^2 = 0.25, p < 0.001), thus providing full confirmation of this relationship.

H2 postulated that value co-creation and firm performance are positively related. The results yielded a significant and positive effect of value co-creation on firm performance, but a very small effect size. f^2 values of 0.02, 0.15, and 0.35 indicate a small, medium, or large effect, respectively, of an exogenous construct on an endogenous construct (Hair et al., 2014). Based on the results (β = 0.16, t = 1.55, f^2 = 0.09, p < 0.05), H2 to achieved 25% confirmation. H3 postulated that open innovation has a positive impact on servitization. The results suggest that the relationship between open innovation and servitization is not significant, with very small effect size (β = -0.09, t = 0.42, f^2 = 0.03, p = NS). Therefore, H3 was not confirmed.

H4 postulated that open innovation positively influences value co-creation. The path between open innovation and value co-creation was significant and positive, with a medium effect size (β = 0.28, t = 5.88, f^2 = 0.26, p < 0.001), thus achieving full confirmation of this relationship.

For H5, which predicted that open innovation would positively influence the firm's absorptive capacity, the relationship was significant and positive, with open innovation is explaining 29% of the variance (R^2) in the absorptive capacity. Based on the results (β = 0.54, t = 7.24, R^2 = 0.29, p < 0.001), there was a 75% confirmation of this relationship. In general, and according to Hairs et al. (2014), in

general, R2 values of 0.75, 0.50, or 0.25 for the endogenous constructs can be described as respectively substantial, moderate, and weak.

H6 predicted that open innovation would positively influence firm performance. However, the path between open innovation and firm performance was not significant and had a small effect size (β = 0.08, t = 1.05, f^2 = 0.04, p = NS), thus providing no confirmation of this relationship.

For H7, which postulated that absorptive capacity positively influences servitization, the path between them was significant and positive, with a medium effect size (β = 0.29, t = 2.56, f^2 = 0.29, p < 0.001), thus achieving full confirmation of this relationship.

For H8, which predicted that absorptive capacity would positively influence firm performance, the path between the two was significant and positive, with a medium effect size (β = 0.24, t = 4.27, f^2 = 0.19, p < 0.001), showing a 75% level of confirmation of this relationship.

H9 postulated that absorptive capacity positively influences value co-creation. The path between absorptive capacity and value co-creation was significant and positive, with a large effect size (β = 0.62, t =13.77, f^2 = 0.37, p < 0.001), thus showing full confirmation of this relationship.

H10 predicted that a service orientation of organisational culture would positively influence servitization. The path between a service orientation of organisational culture and servitization was significant and positive, with a large effect size (β = 0.57, t = 10.69, f^2 = 0.45, p < 0.001), achieving full confirmation of this relationship.

H11 postulated that a service orientation of organisational culture has a positive impact on open innovation. However, the relationship between the two was not significant, with a very small path coefficient (β = 0.009, t = 0.56, p = NS). Therefore, H11 was not confirmed.

H12 postulated that a service orientation of organisational culture positively influences firm performance. The results show a significant relationship between a service orientation of

organisational culture and firm performance, with a medium effect size (β = 0.11, t = 1.96, f^2 = 0.12, p < 0.05). H12 achieved a 50% level of confirmation.

For H13, which predicted that risk would negatively influence servitization, the path between risk and servitization was significant and negative, with a medium effect size (β = -0.303, t = 8.31, f^2 = 0.28, p < 0.001), achieving full confirmation of this relationship.

As table 5-31 shows and with regard to H14, which postulated that industry clock speed moderates the relationship between servitization and firm performance, this relationship was statistically significant (β = 0.15, t = 4.76, f^2 = 0.32, p < 0.001). As shown in figure 5-2, industry clock speed strengthens the positive relationship between servitization and firm performance. To test for moderation and conduct the significance testing for the relationship between the interaction term and industry clock speed, bootstrapping was performed which yielded a significant relationship. The procedure included 185 bootstrap cases and 5,000 bootstrap samples, using the 'no sign changes' option and the product indicator approach. This approach was taken following the recommendations of Hair et al. (2014), as our exogenous latent variable and moderator variable are both measured reflectively.

Table 0-31: Industry clock speed's moderating effect

Variables	Path	T Statistic	P Value
Industry Clock Speed	0.152	4.764	0.001

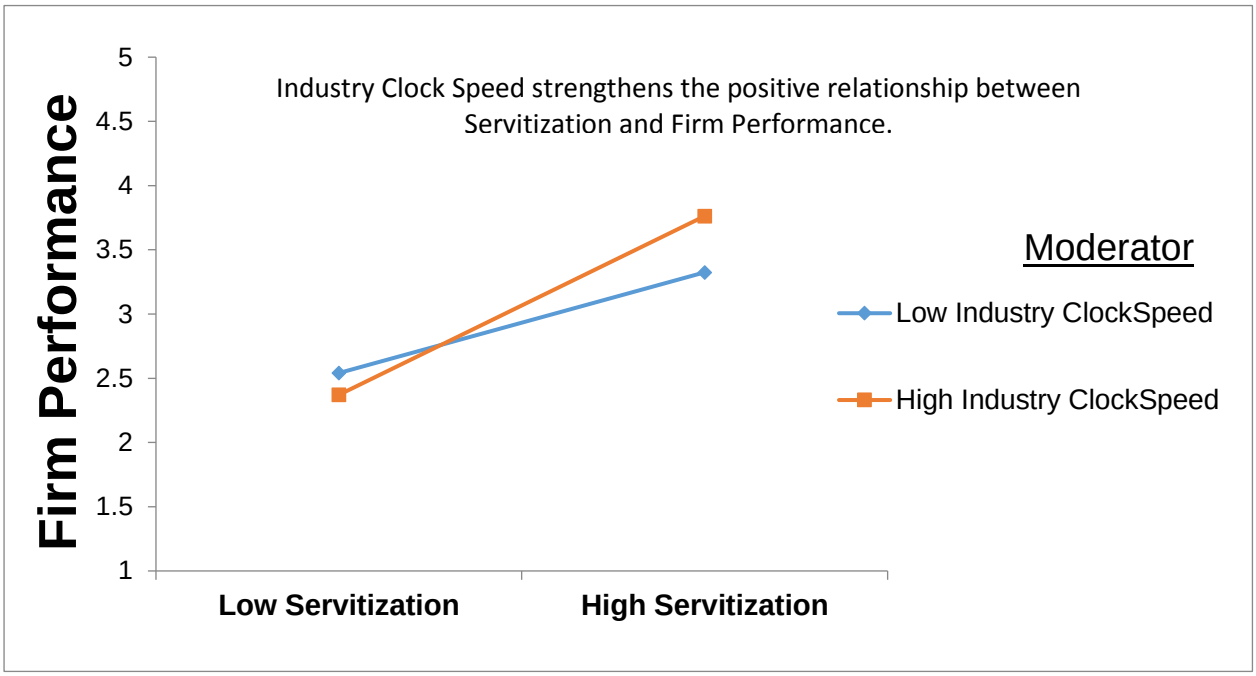

Figure 0-2: Moderating effect of industry clock speed

For H15, which predicted that servitization would influence firm performance, the path between servitization and firm performance was significant and positive, with a large effect size ($\beta = 0.54$, $t = 8.31$, $f^2 = 0.37$, $p < 0.001$), achieving full confirmation of this relationship.

With regard to the control variable findings, company size had a positive impact on firm performance ($\beta = 0.33$, $t = 7.11$, $p < 0.001$), while both firm age and firm industry appeared to have no impact ($\beta = -0.05$ and $\beta = -0.07$, respectively).

Table 0-32: Significance of the path coefficients in the SBM structural model (Bootstrapped at 5000 sample)

Path	Path Coefficient	Mean	Standard Error	T-Value [a]	*P Value*	Significance
Value Co-creation ---⊕---> Servitization	0.311	0.316	0.059	3.080	0.001	***
Value Co-creation ---⊕---> Firm Performance	0.161	0.160	0.073	1.548	0.040	**
Open Innovation ---⊕---> Servitization	-0.086	-0.084	0.036	0.418	0.160	NS
Open Innovation ---⊕---> Value Co-creation	0.283	0.283	0.048	5.886	0.000	***
Open Innovation ---⊕---> Absorptive Capacity	0.536	0.543	0.074	7.240	0.000	***
Open Innovation ---⊕---> Firm Performance	0.076	0.079	0.043	1.050	0.180	NS
Absorptive Capacity ---⊕---> Servitization	0.289	0.282	0.044	2.557	0.011	**
Absorptive Capacity ---⊕---> Firm Performance	0.238	0.238	0.055	4.286	0.000	***
Absorptive Capacity ---⊕---> Value Co-creation	0.621	0.620	0.045	13.775	0.000	***
Service orientation of organisational culture ---⊕---> Servitization	0.572	0.569	0.054	10.697	0.000	***
Service orientation of organisational culture ---⊕---> Open Innovation	0.009	0.009	0.001	0.566	0.520	NS
Service orientation of organisational culture ---⊕---> Firm Performance	0.110	0.117	0.094	1.963	0.030	**
Risk---⊖---> servitization	-0.303	-0.313	0.038	8.314	0.000	***
Industry Clock Speed ---⊕--->Servitization ⊛ Firm Performance	0.152	0.150	0.031	4.764	0.000	***
Servitization ---⊕---> Firm Performance	0.544	0.543	0.063	8.316	0.000	***

As discussed previously, PLS-SEM is regarded as a variance-based approach to SEM, where the algorithm prediction's objective is to maximize the R^2 values of the (target) endogenous constructs (Hairs et al., 2014). In this regard, the study's structural model, and in particular the endogenous latent variable in the model, achieved moderate to substantial explanatory power. The servitization construct achieved an R^2 of 0.85, meaning that the predictive constructs in the SBM managed to explain 85% of the variance in the servitization construct. This is considered substantial explanatory power. The study model also managed to explain 77% of the variance in the firm performance construct, as shown in figure 5-3. The author also calculated the R^2 for the study model while excluding the control variables to unearth the true effect of the main model constructs (see table 5-34). The analysis revealed that the control variables explained only 1% of the variance in the performance construct.

Furthermore, the SBM explained 65% of the variance in value co-creation construct, which is consider substantial. Open innovation and absorptive capacity achieved moderate explanatory power, with R^2 values of 29% and 26%, respectively.

As recommended by Hair et al. (2014), it is paramount to evaluate the magnitude of the R^2 values as a criterion for the predictive accuracy of the structural model, where R^2 values of 0.75, 0.50, or 0.25 for the endogenous constructs represent substantial, moderate, and weak explanatory power, respectively. As shown in figure 5-3, the SBM model managed to explain 77% of the variance in the firm performance construct, 85% of the variance in the servitization construct, and 65% of the variance in the value co-creation construct. These results are considered substantial. The SBM explained 29% of the variance in absorptive capacity and 26% of the variance in open innovation, achieving moderate explanatory power.

Table 5-35 shows the effect sizes for each explanatory latent variable on the study's endogenous variables. This analysis was carried out in two stages. In the first stage, the author calculated the R^2 for the endogenous variables by excluding a specified exogenous construct from the SBM model. This was done to determine whether the excluded construct had a substantial impact on the endogenous constructs. The author then calculated the effect size using the following equation:

$$f^2 = \frac{R^2\ incl - R^2\ excl}{1 - R^2\ incl}$$

Following guidelines for assessing effect size, 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively (Cohen, 1988). The results of the analysis show that servitization had a large effect on firm performance (f^2 = 0.37), while a service orientation of organizational culture had a large effect on servitization (f^2 = 0.45). Risk, absorptive capacity, and value co-creation exhibited medium-sized effects on servitization (f^2 = 0.28, f^2= 0.29, and f^2 = 0.25, respectively).

To assess the SBM's predictive relevance, the study followed the recommendation of Geisser (1974) and Stone (1974) to use Stone-Geisser's Q^2 value as an indicator of the model's predictive relevance. To obtain the Q^2 value, the blindfolding procedure was used for a certain omission distance D. =. Blindfolding is a sample reuse technique that omits every d^{th} data point in the endogenous construct's indicators and estimates the parameters using the remaining data points (Chin, 1998; Henseler et al., 2009; Tenenhaus et al., 2005). This thesis used the cross-validated redundancy as a measure of Q^2, since it includes the key element of the path model – the structural model – to predict eliminated data points (Hair et al., 2014). The Q^2 values estimated using the blindfolding procedure are a measure of how well the path model can predict the originally observed values. Q^2 values above 0 are considered significant and indicate good predictive relevance. As shown in table 5-36, all Q^2's for endogenous constructs in the SBM were above zero, providing additional evidence that SBM exhibits good predictive relevance.

Following the same approach used to asses R^2 values using f^2 effect size, the relative impact of predictive relevance can be compared by measuring the q^2 effect size, which is calculated using the following equation:

$$q^2 = \frac{Q^2\ incl - Q^2\ excl}{1 - Q^2\ \ incl}$$

Similar to the f^2 effect size measure of predictive relevance, q^2 effect size values of 0.02, 0.15, and 0.35 indicate that an exogenous construct has a small, medium, or large predictive relevance, respectively, for a certain endogenous construct (Hair et al., 2014). As shown in table 5-37, servitization showed a large q^2 effect size, and thus large predictive relevance, on firm performance, while value co-creation and absorptive capacity had a large q^2 effect size on servitization.

Overall, as illustrated in figure 5-3, eight of the study hypotheses were fully supported (H1, H4, H7, H9, H10, H13, H14, H15), 3 were rejected (H3, H6, H11), and 4 were partially supported (H2, H5, H8, H12).

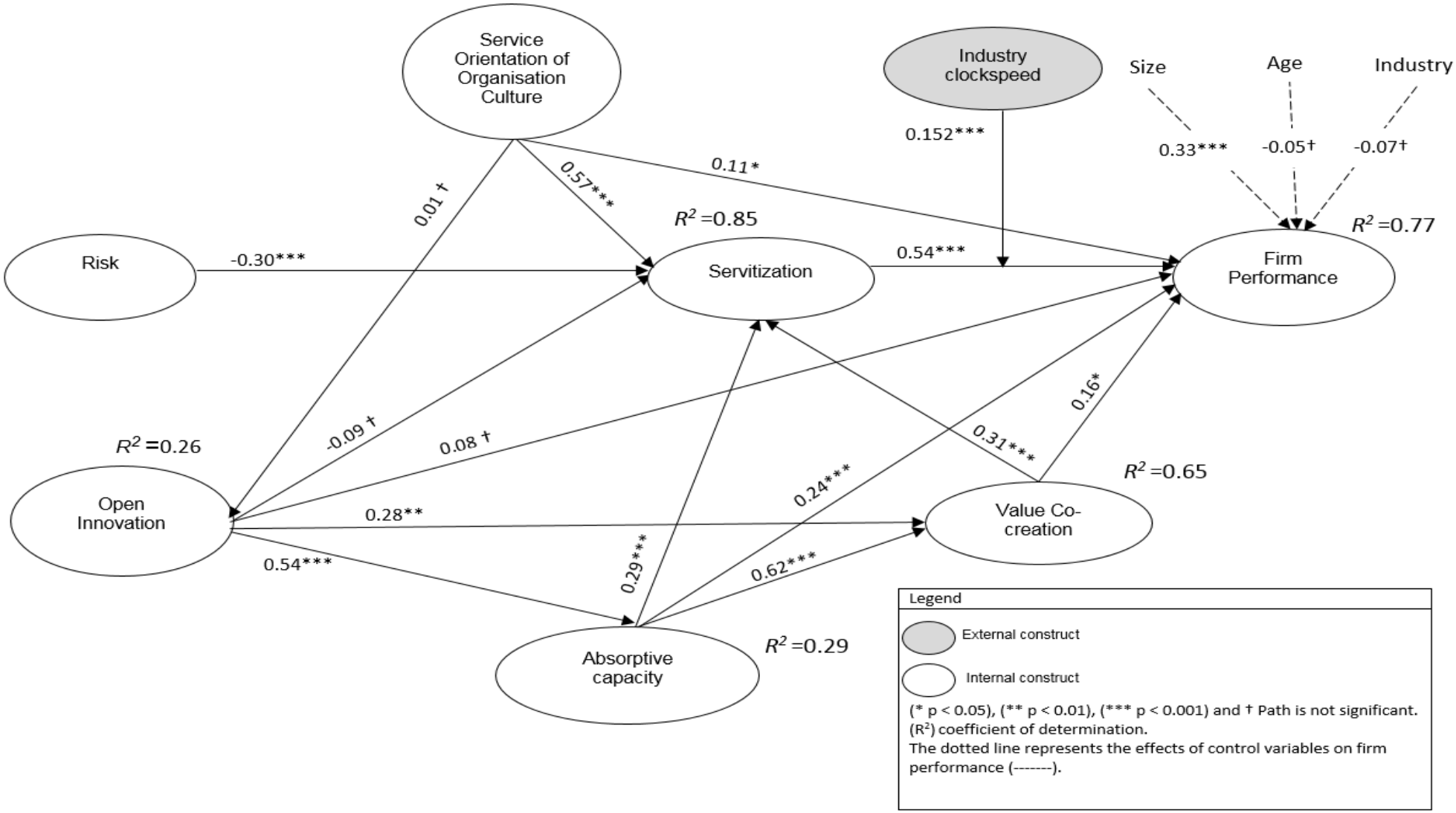

Figure 0-3: Research model testing results

Table 0-33: Degree of confirmation of the hypotheses in the SBM model (n = 185) (notes and legend on the following page)

NO.	Relationship	Significance	Score1[b]	ES/PC[c]	Score 2[d]	R^2	Score 3[e]	Total Score	Degree of Confirmation
H1	Value Co-creation ---⊕---> Servitization	***	3	0.25	3	0.85	4	36	
H2	Value Co-creation ---⊕---> Firm Performance	**	1	0.09	1	0.77	4	4	
H3	Open Innovation ---⊕---> Servitization	NS	0	0.03	1	0.85	4	0	
H4	Open Innovation ---⊕---> Value Co-creation	***	3	0.26	3	0.65	4	36	
H5	Open Innovation ---⊕---> Absorptive Capacity	***	3	0.54	4	0.29	2	24	
H6	Open Innovation ---⊕---> Firm Performance	NS	0	0.04	1	0.77	4	0	
H7	Absorptive Capacity ---⊕---> Servitization	***	2	0.29	4	0.85	4	32	
H8	Absorptive Capacity ---⊕---> Firm Performance	***	3	0.19	2	0.77	4	24	
H9	Absorptive Capacity ---⊕---> Value Co-creation	***	3	0.37	4	0.65	4	48	
H10	Service orientation of organisational culture ---⊕---> Servitization	***	3	0.45	4	0.85	4	48	
H11	Service orientation of organisational culture ---⊕---> Open Innovation	NS	0	0.09	0	0.26	2	0	
H12	Service orientation of organisational culture ---⊕---> Firm Performance	*	1	0.12	2	0.77	4	8	
H13	Risk---⊖---> Servitization	***	3	0.28	3	0.85	4	36	
H14	Industry Clock Speed ---⊕--->Servitization ⊛ Firm performance	***	3	0.32	4	0.77	4	48	
H15	Servitization ---⊕---> Firm performance	***	3	0.37	4	0.77	4	48	

(a) * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, ***NS*** = not significant (two tailed t-test performed in the bootstrapping with 185 cases and 5000 samples)
(b) The significance levels NS, *, **, and *** are given values of 0, 1, 2, and 3 respectively on the score mapping image.
(c) ES= effect size, PC = path coefficient. Note that PC substitutes for ES when the latter cannot be calculated (highlighted in light grey).
(d) ES values between the intervals [0.00, 0.02], [0.02, 0.11], [0.11, 0.20], [0.20, 0.29] and [0.29, 1.00] have corresponding values of 0, 1, 2, 3 and 4 on the scoring image, respectively.

Note that PC values less than the cut-off of 0.20 are deemed unsatisfactory and are given a score of 0 on the scoring image.
PC values between the intervals [0.00, 0.20], [0.20, 0.30], [0.30, 0.40], [0.40, 0.50] and [0.50, 1.00] have corresponding values of 0, 1, 2, 3 and 4 on the scoring image, respectively.

(e) R^2 values between the intervals [0.00, 0.04], [0.04, 0.22], [0.22, 0.40], [0.40, 0.58], and [0.58, 1.00] have corresponding values of 0, 1, 2, 3 and 4 on the scoring image, respectively.
(f) Total score is calculated by multiplying the image scores together (Score1*Score2*Score3), with the minimum score being 0 and the maximum score being 48.

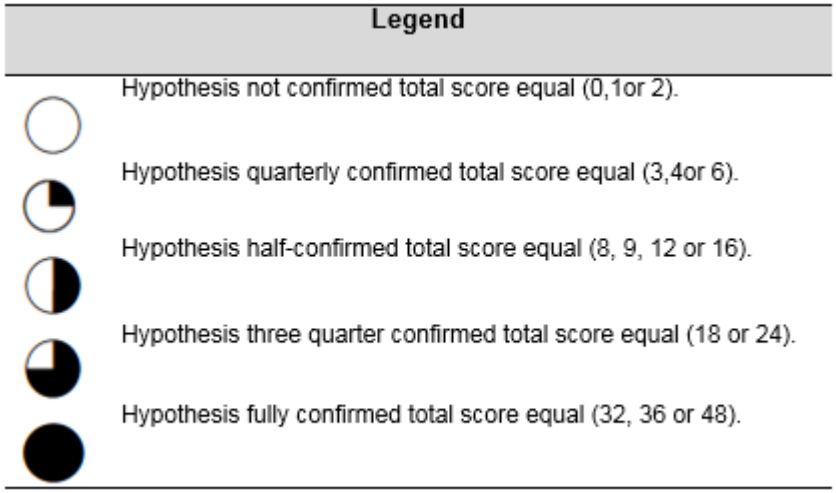

Table 0-34: Comparison of the structural models

Results	Full Model	Control Variables Only Model	Theoretical Variables Only Model
Number of paths in the model	18	3	15
Number of significant paths in the model	13	1	12
Variance explained in firm performance (percent)	77	2.3	76
Additional variance explained by the theoretical variables		77 – 2.3= 74.57percent	
Additional variance explained by the control variables		77– 76 = 1 percent	

Table 0-35: Coefficients of determination (R^2) and effect sizes (f^2) of the latent variables in the SBM model (n = 185)

Latent Variable to be Explored	Explanatory Latent Variable	R^2 incl[a]	R^2 excl[b]	f^2 [d]
Open Innovation	Service orientation of organisational culture	0.26	—[c]	—[c]
	Open Innovation	0.65	0.56	0.26
Value Co-creation	Absorptive Capacity	0.65	0.52	0.37
Absorptive Capacity	Open Innovation	0.29	—[c]	—[c]
	Service orientation of organisational culture	0.85	0.78	0.45
	Open Innovation	0.85	0.85	0.03
Servitization	Value Co-creation	0.85	0.81	0.25
	Absorptive Capacity	0.85	0.81	0.29
	Risk	0.85	0.81	0.28
	Service orientation of organisational culture	0.77	0.74	0.12
	Open Innovation	0.77	0.76	0.04
Firm Performance	Value Co-creation	0.77	0.75	0.09
	Absorptive Capacity	0.77	0.73	0.19
	Servitization	0.77	0.68	0.37

a) R^2 to the explanatory latent variable including its explanatory latent variable.
b) R^2 to the explanatory latent variable in the absence of its explanatory latent variable.
c) Value cannot be calculated for a latent variable with only one explanatory variable.

$$f^2 = \frac{R^2\ incl - R^2\ excl}{1 - R^2\ incl}$$

Table 0-36: Predictive relevance of the endogenous constructs in the SBM model, measured by Stone-Geisser Q^2 criterion.

Dependent Latent Variable	Q^2 (=1-SSE/SSO)
Absorptive Capacity	0.18
Open Innovation	0.17
Firm Performance	0.42
Servitization	0.54
Value Co-creation	0.40

Table 0-37: Coefficients of determination (R^2) and effect sizes (q^2) of the latent variables in the SBM model (n = 185)

Latent Variable to be Explored	Explanatory Latent Variable	Q^2 incl [a]	Q^2 excl[b]	q^2 [d]
Open Innovation	Service orientation of organisational culture	0.17	—[c]	—[c]
	Open Innovation	0.40	0.36	0.07
Value Co-creation	Absorptive Capacity	0.40	0.23	0.28
Absorptive Capacity	Open Innovation	0.18	—[c]	—[c]
	Service orientation of organisational culture	0.54	0.46	0.17
	Open Innovation	0.54	0.54	0.00
Servitization	Value Co-creation	0.54	0.29	0.54
	Absorptive Capacity	0.54	0.40	0.30
	Risk	0.54	0.51	0.07
	Service orientation of organisational culture	0.42	0.40	0.03
	Open Innovation	0.42	0.42	0.00
Firm Performance	Value Co-creation	0.42	0.41	0.02
	Absorptive Capacity	0.42	0.38	0.07
	Servitization	0.42	0.32	0.17

a) Q^2 to the explanatory latent variable including its explanatory latent variable.
b) Q^2 to the explanatory latent variable in the absence of its explanatory latent variable.
c) Value cannot be calculated for a latent variable with only one explanatory variable.

$$q^2 = \frac{Q^2\ incl - Q^2\ excl}{1 - Q^2\ incl}$$

5.5.2 Test for Mediating Effects

The SBM proposed research model has the potential to exhibit some mediation effects. The SBM results provide support for six indirect effects (see table 5-38). Specifically, absorptive capacity may mediate the relationship between open innovation and firm performance ($\beta = 0.13$, $t = 2.38$, $p < 0.05$), absorptive capacity may mediate the relationship between open innovation and value co-creation ($\beta = 0.33$, $t = 7.22$, $p < 0.001$), and more importantly, absorptive capacity may mediate the relationship between open innovation and servitization ($\beta = 0.16$, $t = 5.53$, $p < 0.001$).

Furthermore, servitization may mediate the relationship between risk and firm performance ($\beta = -0.16$, $t = 2.78$, $p < 0.05$), servitization may mediate the relationship between service orientation of organisational culture and firm performance ($\beta = -0.31$, $t = 8.82$, $p < 0.001$), and servitization may mediate the relationship between value co-creation and firm performance ($\beta = -0.31$, $t = 11.26$, $p < 0.001$).

The procedure used for the mediation analysis was based on bootstrapped SEM (n=5000 bootstrap resamples) (Zhao, Lynch Jr, and Chen, 2010), and was done to establish the statistical significance of the indirect effect and measure its magnitude (Hayes, 2009). The procedure was also based on the path coefficients and standard errors of the direct paths between, first, the independent and mediating variables (IV → Mediator), and second, the mediator and dependent variables (Mediator → DV) (see table 5-39). The indirect effect in this relationship was calculated as the product of the direct paths from IV to Mediator and Mediator to DV.

For example, since servitization was found to mediate the relationship between value co-creation and firm performance, the indirect effect of value co-creation on firm performance was calculated as follows. First, the author calculated the direct effect of value co-creation (IV) on servitization (M), resulting in $\beta = 0.31$. Second, the author calculated the direct effect of servitization (M) on firm performance (DV), which was equal to $\beta = 0.54$. Finally, the indirect effect was calculated by multiplying the effects ($0.31*0.54 = 0.16$). To calculate the total effect, the author added the

indirect effect to the direct effect. In this example, the total effect of value co-creation on firm performance was equal to 0.16 (indirect effect) + 0.16 (direct effect) = 0.32. Table 5-40 and table 5-41 show the total effect of the variables on both the servitization construct and the firm performance construct, as well as the ranking of the effects of the other variables in the SBM on those two constructs (servitization and firm performance). These findings provide the basis for some of the theoretical and practical conclusions presented in the following chapter.

Table 0-38: Specific indirect effects

Path	Specific Indirect Effects
OI -> AC -> PER	0.129*
OI -> AC -> SERV -> PER	0.031
OI -> SERV -> PER	-0.044
RISK -> SERV -> PER	-0.157*
SC -> SERV -> PER	0.306*
OI -> AC -> VCC -> SERV -> PER	0.021
OI -> VCC -> SERV -> PER	0.018
OI -> AC -> VCC -> PER	0.029
OI -> VCC -> PER	0.025
OI -> AC -> SERV	0.157
OI -> AC -> VCC -> SERV	0.041
OI -> VCC -> SERV	0.136*
OI -> AC -> VCC	0.334*
VCC -> SERV -> PER	0.167*

* Indicates 0.05 level of significance.

Table 0-39: Significance of mediated paths

Indirect effect	Mediated path	Path coefficient (indirect effect)	T statistic
OI -> PER	OI -> AC -> PER	0.129	2.375**
OI -> VCC	OI -> AC -> VCC	0.334	7.220***
OI -> SERV	OI -> AC -> SERV	0.157	5.526***
RK -> PER	RK -> SERV -> PER	-0.157	2.786**
SC -> PER	SC -> SERV -> PER	0.306	8.816***
VCC -> PER	VCC -> SERV -> PER	0.164	11.257***

Note: Indirect effect estimates are based on bootstrapped SEM and reported in standardized form.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The PLS SEM analysis technique was used to calculate the extent to which a variable mediated the relationship under investigation, the use of bootstrapping technique to test for mediation is recommended by Preacher and Hayes (2004, 2008). Because bootstrapping fits perfectly with the PLS-SEM method, as it does not require any assumptions to be made about the shape of the variables' distribution or the sampling distribution. In addition, the approach exhibits higher levels of statistical power compared with the Sobel test (Hair et al., 2014).

To address the issue of the extent to which the mediator variable absorbs some or all of the direct effect between the exogenous and endogenous latent variables, the author estimated the size of the indirect effect following Hair et al.'s (2014) recommendation of using variance accounted for (VAF) to determine the size of the indirect effect in relation to the total effect, were VAF is calculated as the ratio of the indirect effect to the total effect. If the ratio is greater than 1 it indicates full mediation, while if the ratio is less than one it indicates partial mediation. In our study, absorptive capacity appeared to be a full mediator between open innovation and firm performance (VAF= 0.13/0.08 = 1.6), and open innovation and servitization (VAF= 0.16/0.09 = 1.7), while absorptive capacity partially mediated the relationship between open innovation and value co-creation (VAF= 0.28/0.33 = 0.84).

Another interesting finding was that servitization fully mediated the relationship between service orientation of organizational culture and firm performance (VAF = 0.31/0.11 = 2.8). Servitization partially mediated the relationship between risk and performance (VAF = -0.16/-0.09 =-1.7), and it was found to mediate the relationship between value co-creation and firm performance (VAF = 0.16/0.16 = 1). The results suggest that improving both servitization and value co-creation will enhance firm performance.

Overall, the results obtained were deemed to be satisfactory and to have great theoretical importance, as they were consistent with theoretical expectations. Therefore, the nomological validity of the research model was confirmed, since servitization was shown to have a significant positive impact on firm performance (R^2 = 0.77). Servitization was also recognized as a strong mediator.

The direct, indirect and total effects of the significant variables on servitization and firm performance are shown in table 5-40 and table 5-41, respectively. It can be seen from table 5-40 that five latent constructs showed a significant relationship with servitization. Table 5-41 shows that four latent constructs – value co-creation (indirect path coefficient = 0.16), service orientation of organisational culture (indirect path coefficient = 0.31), risk (indirect path coefficient = –0.16) and open innovation (indirect path coefficient =0.13) – had significant relationships with firm performance (see Table 5-41 for the construct total effect and the ranking of construct effects).

Finally, the statistical examination of the research framework resulted in significant R^2, Q^2 and GoF values. This indicates strong explanatory power and predictive relevance for the SBM. In other words, the ability of the SBM model to predict firm performance in a servitized context has been statistically confirmed.

Table 0-40: Total effect of the significant variables on servitization

Variables	Direct	Indirect	Total	Rank order
Absorptive Capacity	0.29***	-	0.29***	**4**
Value Co-creation	0.31***	-	0.31***	**2**
Service Culture	0.57***	-	0.57***	**1**
Risk	-0.30***	-	-0.30***	**3**
Open Innovation	-	0.16*	0.16*	**5**

* p < 0.05, ** p < 0.01, *** p < 0.001

Direct and Indirect effects are reported in a rounded standardized form.

Table 0-41: Total effect of the significant variables on firm performance

Variables	Direct	Indirect	Total	Rank order
Servitization	0.54***	-	0.54***	**1**
Absorptive Capacity	0.24***	-	0.24***	**4**
Value Co-creation	0.16*	0.16*	0.32*	**3**
Service Culture	0.11	0.31***	0.42***	**2**
Risk	-	-0.16*	-0.16*	**5**
Open Innovation	-	0.13*	0.13*	**6**

* p < 0.05, ** p < 0.01, *** p < 0.001

Direct and Indirect effects are reported in rounded standardized form.

5.6 Groups Comparison and Analysis

In order to address and tackle heterogeneity in a sample, comparing several groups of respondents is beneficial from a practical and theoretical perspective, as understanding group-specific effects facilitates further differentiated findings. In this regard, group analyses were carried out to determine whether the variances of the parameter estimates (from bootstrapping) differed significantly across the study groups. Levene's test was used to obtain the values for the comparison (Mooi and Sarstedt, 2011). Furthermore, Smart PLS has a functionality that addresses the group analysis calculation based on resampling the path coefficients of the t-value according to the following formula:

$$t = \frac{p_1 - p_2}{\left[\sqrt{\frac{(m-1)^2}{(m+n-2)} * se_1^2 + \frac{(n-1)}{(m+n-2)} * se_2^2}\right] * \sqrt{\frac{1}{m} + \frac{1}{n}}}$$

p1 = Path coefficient from subsample 1

p2 = Path coefficient from subsample 2

se1 = Standard error of the parameter estimate of subsample 1

se2 = Standard error of the parameter estimate of subsample 2

m = Size subsample 1

n = Size subsample 2

To ensure robustness, the group comparison was carried in both group models using exactly the same indicators (Chin, 2003). Table 5-42 shows the outcomes of the group comparison between manufacturing firms that generate low revenue from service offerings –companies with less than 30% of services from total revenue- (n=144) (see table 5-26) and those that generate high revenue from service offerings (more than 30%) (n=41). As can be seen from the table 5-42, the path coefficients were consistently highly significant for both groups. With regard to the coefficient of determination for the structural model, both groups behaved analogously to the aggregated sample: The R^2 of firm performance was smaller in each group, but was still greater than or equal to the cut-off value of 0.2. Therefore, for both samples, the explanatory power of the structural model was empirically demonstrated.

An additional interesting finding was that the t-values for the group comparison showed significant differences ($p < 0.05$) between the following two paths in the structural models:

- **Value Co-creation** → **Servitization**: Value co-creation was shown to have a greater influence on servitization in companies with a low degree of servitization than it does in companies with a high degree of servitization.

- **Servitization → Firm Performance:** The influence of servitization on firm performance was found to be higher in companies with a low degree of service offerings than in companies with a high degree of service offerings.

One striking feature of the findings is the degree of influence that servitization exerted on firm performance in the comparison groups (low degree of servitization vs. high degree of servitization). The implications of such findings, which can influence the service offering design and service introduction, will be discussed in the following chapter.

Table 0-42: Comparison of path coefficients in the SBM for companies with low vs. high revenues from services (n = 144 and 41, respectively)

pathway	Key figures						
	Low (n = 144)			High (n = 41)			Group Comparison
	Path coefficient	Standard error	T value [a]	Path coefficient	Standard error	T value [a]	T value [a]
Value Co-creation ------> Servitization	0.28	0.06	10.63***	0.15	0.15	1.79**	2.38***
Value Co-creation ------> Firm Performance	0.59	0.05	6.21***	0.59	0.11	3.85***	0.52 [NS]
Open Innovation ------> Servitization	0.12	0.06	4.05***	0.11	0.11	1.08 [NS]	1.78· [NS]
Open Innovation ------> Value Co-creation	0.12	0.06	4.77***	0.12	0.08	4.22***	0.75 [NS]
Open Innovation ------> Absorptive Capacity	0.09	0.05	5.24***	0.13	0.08	3.51***	0.60 [NS]
Open Innovation ------> Firm Performance	0.08	0.05	12.20***	0.08	0.13	3.80***	1.14 [NS]
Absorptive Capacity ----> Servitization	0.89	0.06	3.14***	0.89	0.12	2.50***	0.92 [NS]
Absorptive Capacity ----> Firm Performance	0.62	0.06	4.53***	0.61	0.14	3.19***	1.15 [NS]
Absorptive Capacity ----> Value Co-creation	0.60	0.05	5.91***	0.53	0.09	1.58*	1.62**
Risk------> Servitization	-0.30	005	11.30***	-0.35	0.08	7.14***	0.66 [NS]
Servitization ------> Firm Performance	0.50	005	9.30***	0.35	0.08	7.24***	3.81**

Table 5-42 continued

	Key figure	
	Low (n = 144)	**High (n = 41)**
	R^2	**R^2**
Open Innovation	0.21	0.22
Absorptive Capacity	0.42	0.63
Value Co-creation	0.28	0.40
Servitization	0.71	0.67
Firm Performance	0.65	0.62

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, NS = Not significant (error probability for one-tailed t-test).

5.7 Testing the SBM Model Using Objective Performance Data

To ensure the robustness of our findings and to further validate the study's structural model (SBM), the SBM was tested with firm performance data collected from the OSIRIS database. As discussed in Section 4.7, prior management studies (e.g., Ravichandran, Lertwongsatien, and Lertwongsatien, 2005; Brown et al., 1995; Ge, Wang, and Wang, 2018) have used many different financial ratios and stock market based metrics and variables to operationalise firm performance. In particular, return on assets (ROA) and return on sales (ROS) have been widely used as indicators of financial performance, measuring rate of return (Ravichandran, Lertwongsatien and Lertwongsatien, 2005).

Following such studies, the author used ROS and ROA as indicators of financial performance. ROS represents the operational efficacy of the company, measuring the net contribution of the revenues to profits, which highlights the operating costs associated with revenue generation. The successful introduction of a servitized offer can be expected to improve the manufacturer's efficiency by streamlining business processes, outsourcing some operations, and cutting waste, thereby reducing operating costs. The ROA ratio can be used to evaluate the ability of the company to deploy its overall resources to a productive use. In a servitized context, ineffective plant operations and bloated supply chains can increase the capital used to generate sustainable revenue streams, compared with more streamlined supply chains that support product and service delivery. From a capability perspective, as argued previously, delivering servitized offerings now requires the effective use of the firm's digital resources to cut cost and effectively utilize their capital assets.

Consistent with prior literature (Henderson and Venkatraman, 1993; Ravichandran, Lertwongsatien, and Lertwongsatien, 2005), the author used sales growth as proxy for market-based performance. In this thesis, sales growth was used to measure how well the manufactures were performing in the marketplace, as determined by how often they introduce new products/services whether they have effective customer targeting, and whether they satisfy customer needs. The effective introduction of servitization can streamline and speed up the process of new product

development and enable better relations with customers, increasing the understanding of their needs and responsiveness to their service requests, resulting in better performance in the marketplace.

After laying down the conceptual foundation of firm performance, the author introduced three models with each of the three performance indicators (ROS, ROA, and sales growth) used as dependent variables. These were considered appropriate measures, considering the multidimensionality of the performance construct. Therefore, firm performance was operationalised as a composite of the annual firm performance during the focal period of study (2013– 2015).

In the first mode, firm performance was operationalized as a reflective construct, with ROS values for the years of 2013, 2014, and 2015 used as indicators for the construct. Similarly, ROA values for 2013, 2014, and 2015 were used as indicators of firm performance in the second model, and the average sales growth from 2013 to 2015 was used as an indicator of firm performance in the third model. All other parameters were kept exactly as they were in the SBM model tested with subjective firm performance measures. All three measurement models were supported and all indicator loadings were significant and above the threshold of 0.4. No weaknesses were detected after assessing the quality criteria of the measurement model.

The results of the structural models are presented in table 5-44. The results are to some extent consistent with those obtained with the subjective performance measures; the relationships between servitization and firm financial performance, and between servitization and firm market performance, were supported in all three model, while all other structural paths maintained their significance. Each of three models accounted for approximately 20 percent of the variance in firm performance (25 percent for ROS, 22 percent for ROA, and 19 percent for sales growth). Although lower than the variance in firm performance explained by our original model (see table 5-43), these results are highly similar to the results reported in other operational and strategic management literature that used objectively measured financial ratios as indicators of firm performance (Ravichandran, Lertwongsatien, and Lertwongsatien, 2005; Powell, 1995). Considering the problems associated with

using secondary data sources such as OSIRIS, and the fact that there are a host of factors in the measurement model have not been accounted for that can also explain variance in firm financial and market performance, the results reported here are significant and reinforce our finding that servitization positively influences firm performance.

Table 0-43: Coefficient of determination of the endogenous constructs in the objective models vs. SBM

Dependent Latent Variable	R^2 SBM	Model 1 (ROS)	Model 2 (ROA)	Model 3 (Sales Growth)
Open Innovation	0.26	0.25	0.26	0.24
Value Co-creation	0.65	0.63	0.63	0.62
Absorptive Capacity	0.29	0.29	0.28	0.29
Servitization	0.85	0.85	0.83	0.80
Firm Performance	0.77	0.25	0.22	0.19

Table 0-44: Model Comparison. Subjective firm performance measures vs. objective firm performance measures (N=185)

Path	SBM	Model 1 (ROS)	Model 2 (ROA)	Model 3 (Sales Growth)	Significance
Value Co-creation ---⊕---> Servitization	0.31	0.32	0.29	0.38	***
Value Co-creation ---⊕---> Firm Performance	0.16	0.16	0.19	0.15	**
Open Innovation ---⊕---> Servitization	-0.09	-0.07	0.03	0.04	NS
Open Innovation ---⊕---> Value Co-creation	0.28	0.31	0.29	0.32	***
Open Innovation ---⊕---> Absorptive Capacity	0.54	0.56	0.59	0.49	***
Open Innovation ---⊕---> Firm Performance	0.08	0.07	0.04	0.09	NS
Absorptive Capacity ---⊕---> Servitization	0.29	0.35	0.21	0.30	**
Absorptive Capacity ---⊕---> Firm Performance	0.24	0.28	0.25	0.26	***
Absorptive Capacity ---⊕---> Value Co-creation	0.62	0.70	0.45	0.76	***
Service orientation of organisational culture ---⊕---> Servitization	0.57	0.49	0.40	0.45	***
Service orientation of organisational culture ---⊕---> Open Innovation	0.01	0.00	0.01	0.07	NS
Service orientation of organisational culture ---⊕---> Firm Performance	0.11	0.17	0.20	0.21	**
Risk---⊖---> Servitization	-0.30	-0.31	0.35	0.32	***
Industry clock Speed ---⊕---> Servitization ⊛ Firm Performance	0.15	0.170	0.20	0.20	***
Servitization ---⊕---> Firm Performance	0.54***	0.29*	0.26*	0.23*	---

* p < 0.05; ** p < 0.01; *** p < 0.001; NS = not significant.

CHAPTER 6

Conclusions, Implications and Critical Discussion

6.1 Introduction

This chapter dwells on the conclusions relating to the research questions. It also presents the scientific significance of this thesis and its original contribution to knowledge, in terms of theoretical and managerial contribution, this chapter also outlines new avenues for future research and highlights some limitations of this current research.

6.2 Overview of Research

As product market is currently suffering from both commoditization and stagnation manufacturing companies are showing invigorated interest in offering innovative solutions by tapping into servitization in order to sustain their competitive advantage and market performance. To achieve this, manufacturers must develop a new set of resources and capabilities for that will allow them to introduce industrial services. The introduction of servitization can be leveraged by capitalising on the firm-specific learning and strategic capabilities that can help in the journey of business-model change and organizational transformation. This thesis aimed to develop a model of servitization antecedents to assist and guide manufacturing firms to formulate strategies to achieve and maintain superior performance. To achieve this aim, the following four research questions were posed within the context of manufacturing firms:

1. What is servitization and how can it be conceptualized, operationalized and measured?

2. What are the major internal and external factors driving servitization in manufacturing companies?

3. What are the relationships between external industry factors, servitization, and organisational performance in the context of manufacturing firms?

4. What is the existent relationship between servitization and firm performance and how they are bounded by organisational context?

This thesis reviewed the theories of strategic management, operation management and marketing and applied these theories within the context of servitized manufacturing firms. The theoretical framework developed in this thesis is grounded by integrating RBV theory, transaction cost theory, social network theory, attention based view theory contingency theory to achieve competitive advantage. These theoretical perspectives were combined to provide the theoretical foundation to study servitization and its antecedents. These theoretical lenses were also used in a complementary manner in explaining the effects of external industry factors and internal servitization drivers, which in turn determine organizational performance.

Prior empirical studies investigated the impact of servitization on the firm's financial performance (e.g. Eggert et al., 2014; Fang et al., 2008; Kastalli & Van Looy, 2013; Kohtamäki et al., 2013; Suarez et al., 2013) have produced conflicting results and vividly addressed the "servitization paradox" (Gebauer et al., 2005). Despite the valuable insight gained from the servitization literature, most of the evidence reviewed is either anecdotal or based on case studies, and a large-scale empirical proof of the relationship between the implementation of services, capabilities and firm performance is still scant, vague and far from conclusive (Baines, 2015; Benedettini et al., 2015; Eggert et al., 2014).

This research was undertaken to extend the literature on servitization of manufacturing firms with a view to providing insights into the major antecedents of servitization and how servitization can impact organisational performance.

Having developed a theoretical framework, the methodological approach best suited to address the hypothesised relationship were considered. Quantitative research design was followed. A questionnaire was used to survey a large sample of senior managers regarding their firms servitization practice and their internal servitization processes. This would help determine the relationship between different servitization antecedents employed by manufacturing firms, and how this might impact their firm performance. A total of 185 firm from different manufacturing sectors in the US and Europe participated in this research. And PLS-SEM was used to statistically examine a framework for direct causal relationships, causal moderating relationships and finally, mediating relationships between the research model constructs.

This thesis empirical investigation of the relationships between the antecedents of servitization, servitization and firm performance, was driven by multidimensional perspective that took into consideration the interplay of both external and internal factors influencing servitization and firm performance. This research main finding in this regard is that the introduction of servitization can be leveraged by capitalising on the firm-specific learning and strategic capabilities that can help in the journey of business-model change and organizational transformation. This research has shown that such capabilities do enhance servitization and firm performance.

6.3 Conclusions Regarding the Research Questions

6.3.1 Servitization Conceptualization and Operationalization

The first research question guiding this research sought to find a workable definition of servitization that can be applied specifically to manufacturing firms in B2B context. This research maintained the definition of servitization as a change in the manufacturing business model, to incorporate more service elements into its business model. To do so manufacturing firms have to undergo a transformational process of shifting from a product-centric business model and logic to a service-centric approach, making their customers' needs their core focus, and provide them with solution instead of products.

This research also introduced a novel operationalization of the servitization concept in which this thesis examined the servitization construct. This construct found to be spanning three main dimensions namely "top management service orientation", "mobilization of organizational resources" and the market offering", these three pillars formed the base of the novel servitization scale introduced to measure servitization. A list of 12 indicators for measuring the sevitization of manufacturing firms were developed using the C-OAR-SE methoed and validated as apropertae.

6.3.2 Internal Anteceddents of Servitization

The second research question aimed to identify the major internal and external antecedents of servitization. Building on prior literature (Baines, 2009; Gebauer et al., 2005, Kohtamäki et al., 2013)

The findings of this study illustrated that the most important antecedents od servitization are as follows:

First, service orientation of organizational culture was shown to play the most important role in enabling servitization, and servitization in turn augment the impact of a service orientation of organizational culture on the bottom-line results. The results from our path analysis and the causal relationships that explain the relationship between service orientation of organizational culture,

servitization and firm performance are significant. In line with Gebauer (2008), the study results reveal that a service orientation of organisational culture is a key variable in the successful formulation and implementation of a business strategy that includes servitized offerings. Consequently, from both the practical and attention-based theoretical perspectives, achieving high managerial recognition and improving the service orientation of the organizational culture are critical steps in offering servitization. Both require a fundamental change in the product mindset prevalent in the pure industrial context to more customer-centric approach (Kindström and Kowalkowski, 2015). Otherwise, manufacturers are at risk of losing their strategic focus if they do not manage the transition properly (Fang et al., 2008). It is also important to mention that the existing empirical evidence provides weak support for a positive association between service culture and firm performance (Homburg et al., 2003) because this relationship is mediated by the actual materialization of a service implementation, by the introduction of servitization.

Second, value co-creation was found to be the second most important antecedent of servitization, as it plays a critical role in redefining clients' problems and discovering hidden demand (Kim and Mauborgne, 1999; Matthyssens and Vandenbempt, 2008). One of the main premises of servitization is that it creates customer-centric solutions (Normann and Ramirez, 1998), emphasising the need for firms to change or renew their resources and capabilities in order to deliver value in use. Therefore, manufacturing companies undergoing servitization must involve customers in their daily business operations, bearing in mind that value creation can be better understood by taking the service dominant (S-D) logic into account (Vargo and Lusch, 2004a; Edvardsson et al., 2011). Consequently, manufacturing firms operating in a B2B context should focus on long-term relationship-building, which leads to sustainable streams of revenue.

Third, risk, as perceived by the mangers involved in steering servitization strategies across functions, was found to be the third most important factor, and it can hinder the implementation of servitization, as shown by a strong negative effect of risk on servitization. For an in-depth

interpretation of the results concerning the weights of the risk construct items, see Chapter 4. It can be concluded that the risk construct was highly marked by psychological risk, unjustified overall implementation risk and financial risk perceptions. These findings confirm the previous literature (Benedettini etal., 2015), which found that risk in a servitized context stems from the classic agency problem (Makri and Neely, 2016). Therefore, this issue must be addressed when designing new servitized offers.

There is also an important managerial implication related to the communication polices adopted by businesses to establish the primary communication objectives for newly introduced strategies. Such policies might include creating awareness of the benefits of servitization, promoting service sales, enhancing internal and external collaboration with the product and service design functions, encouraging or discouraging certain practices, and enhancing servitization acceptance levels.

Furthermore, most servitization offers are induced by pull from customers and push from technology to supply such an offer (Baines and Lightfoot, 2013). Therefore, manufacturers must educate their customers about the benefits and risks of servitization, and whether services would enhance the customers' operational effectiveness and overall success.

Communication policies are considered vital in such context, as manufacturers must ensure that their offer encapsulates 3 characteristics. First, the servitized offer must ensure customer intimacy by combining detailed customer knowledge with operational flexibility; this will create the best total solution for the customer. Second, operational excellence must be achieved by controlling processes so as to effectively deliver the best total cost to the customer. Finally, they must ensure product leadership by selling the best product on the market.

Fourth, absorptive capacity has been found as the fourth most important antecedent of servitization, as this thesis results reveal that it can influence both servitization strategies and firm performance. The study results also suggest that absorptive capacity is an important capability that supports the growing demand from manufacturing firms for knowledge intensive services (KIS) (Cusumano et al., 2015), in which acquiring, assimilating and exploiting external knowledge is paramount and, more importantly, can help firms turn such knowledge into services that stimulate growth (Macpherson and Holt, 2007).

Besides this finding, this reserch also confirmed that absorptive capacity in manufacturing firms enhances firm financial and market performance, which is in line with Westerman et al.'s (2014) findings. This relationship can be explained by the fact that absorptive capacity can play an enabler role for servitization, as manufacturers are increasingly adapting their business models to incorporate more capabilities to acquire external knowledge and apply it to commercial uses (Dellarocas, 2003), to increase their value proposition (Lusch, Vargo, and Tanniru, 2010), and most importantly to unlock operational agility and efficiency (BarNir, Gallaugher, and Auger, 2003), all leading to improved financial performance (Gebauer et al., 2010).

Furthermore, the impact of open innovation on servitization and firm performance revealed by the present study actually contradicts the current literature that advocates a direct positive impact of openness on servitization and firm performance (e.g., Visnjic and Looy, 2013; Chesbrough, 2011); these relationships failed to materialize in our causal examination, providing a new perspective into the nature and the practice of open innovation in a servitized manufacturing context. Our findings also showed how manufacturing firms tap into network partners they exploit as “value-generators”; these partners provide a source of innovation and new commercial ideas that can generate high returns through the introduction of service provision. An interesting explanation of such an effect can be found in the very process by which manufacturers perform R&D, which is widely built on in-house capabilities and resources – the closed innovation paradigm (see Section 3.3.2.2). This is done to

counter any negative effects from dual involvements in the process of acquiring new innovation. Gans and Stern (2002), for example, found that a high degree of customer or partner involvement when searching for innovative solutions could actually hinder a firm's innovation stance and increase risk. Such a phenomenon may lead manufacturing companies to be very risk averse and reluctant to transcend firm boundaries, as the firm boundary theory and servitization literature suggest (Huikkola and Kohtamäki, 2017).

Furthermore, servitization is in some respects viewed as a repositioning manoeuvre that involves boundary (re)definition (Chandraprakaikul et al., 2010; Teece et al., 1997). In the manufacturing context, requires designing a proper product-service offering and deciding which value-adding activities should be performed internally; which should be outsourced to suppliers, partners, distributors, and/or customers (Baines et al., 2005); and which can be designed collaboratively, relying on open innovation activities (Neely, 2015).

This research, however, does not completely reject the importance of open innovation. In some industries, openness can still offer a great deal of healthy interaction that facilitates the combination, assimilation and transformation of knowledge inputs from diverse channels. It can also give firms unique access to assets needed to generate value from new ideas (Christensen et al., 2005; Teece, 1986). And as our results indicate, open innovation can influence servitization and firm performance via the mediating effect of absorptive capacity.

Finally, this study results also provide novel insights into this relationship in the context of servitized manufacturers. This thesis found that servitization plays a significant mediating role between value co-creation and firm financial performance. This can be explained by the effect of embedding value co-creation activities such as co-design and co-production aspects into the service offering, which in turn enhances the customer experience, reduces down time and cuts costs for both the manufacturer and the customer. Such a situation can be achieved by using predictive asset management technologies and collaborative platforms. Thus, the main goal of value co-creation in a

servitized context is to increase the productivity and/or effectiveness of both the supplier and the consumer, taking into consideration the idea that providing value in use is a dynamic process due to changes in the customer's objectives through the different stages of the relationship (Macdonald et al., 2011).

6.3.3 Major External Factors in Influencing and Determining the Relationship between Servtization and Firm Performance

The third research question aimed to ascertain the major factors of external environment, that might influence the relationship between servitzation and firm performance. The study highlighted that there is a major industry level forces influencing the servitization strategy and firm performance in manufacturing firms. This factor is called industry dynamism and clock speed, which influence the firm's servitization strategies. This factor can be explained as the shift to service provision may be motivated or influenced by changes in the firm environment, for instance, changes in competitive pressure, technological changes, evolution of public regulations, and improvement of transportation and telecommunications infrastructures (Crozet and Milet, 2017). A good example of the impact of industry clock speed can be found in industries where product lifecycles are short, which is the case in many industries. Manufacturers must keep up with market demands by introducing more products and services, thus enhancing servitization. Interestingly enough, industry dynamism also affects customer involvement and value co-creation. Therefore, in turbulent environments, a higher service offering can lead to better performance, a finding that adds support to those of Fang et al. (2008). This important external factor found in this thesis to play a moderator role between servitization and firm performance.

While manufacturing firms formulating and implementing their servitization strategies. They must adhere to the externalities in the surrounding, those rapid industrial changes can come in form of, change in the technology landscape, manifested in introducing new digital technologies which might change the rule of the game for incumbents, the change in the firm structure also plays a major role in influencing servitization strategy, the mergers and acquisition happened every day in the

manufacturing firms needs special attention in order to acquire know how in service. Furthermore, in servitization strategies must be revised on a regular basis to stay compatible with, and relevant to, market needs and the ever evolving dynamic environment.

6.3.4 Servitization Impact on Firm Performance

The fourth research question aimed to examine the relationships between servitization and firm performance. This research reveals a positive direct impact of servitization on firm performance which is in line with prior empirical studies that investigated the same relationship (e.g., Eggert et al., 2014; Fang et al., 2008; Kastalli and Van Looy, 2013; Kohtamäki et al., 2013; Suarez et al., 2013). This research indicates that a higher degree of service offering leads to higher profitability and market value for manufacturing firms. Furthermore, this thesis found that organizational performance may vary considerably from one manufacturing firm to another, because of the level of servitization as high level of servitizated companies were less financial sound than those with early stages of servitization in other word low level of servitization. This performance discrepancy is taking place because of the high financial commitments of those companies encounter when dealing with advance services and long term contracts for asset management and solution offerings, while low servitized firms required marginal financial commitment in less complex products and contracts. They difference between those both strands of servitization is the level of internal resources integration and the internalization of new external knowledge and the perceptions of the external industry structure they operate within.

In addition, this study found that the major two antecedents of the firm performance in manufacturing context were, namely ‘servitization’ and ‘service orientation of organizational culture’, and highly drive superior firm performance. This is particularly the case when manufacturing firms are well equipped with a pool of learning capabilities in terms of the absorptive capacity and the continuous development of R&D capabilities. These elements serve as inputs to the servitization strategy and knowledge management system and determine the quality of the output (i.e. organizational performance).

Figure 6-1 presents an integrated model of servitization of manufacturing firms which has been developed as a result of this research. This framework presents a range of context-specific antecedents of servitization which the interdependencies between major constructs of the model and firm performance within the context of servitized manufacturing. These constructs are: external industry factors and internal firm process. This research statistically inferring causality between those articulated constructs of the model.

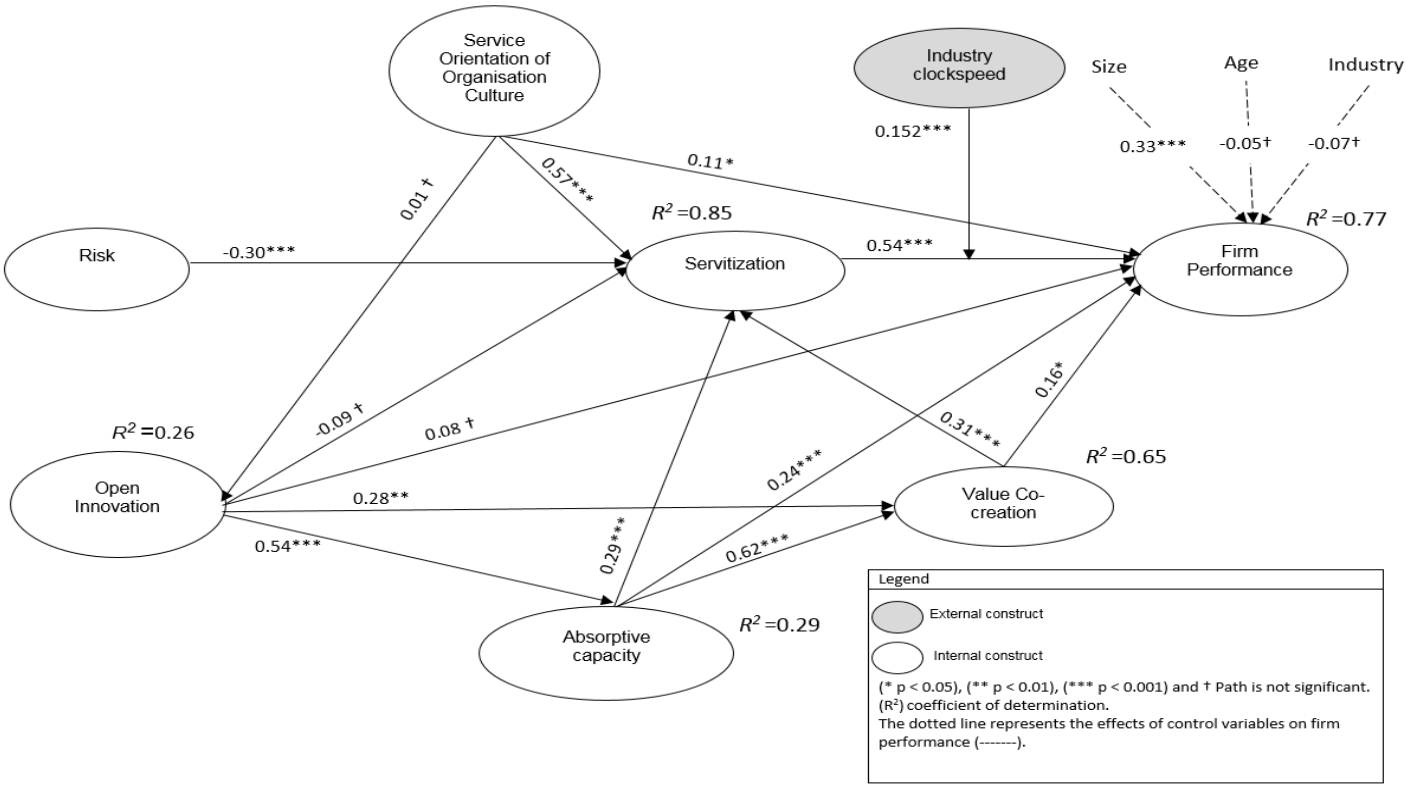

Figure 6-1: Research model

The framework, presented in Figure 6-1, highlights that there are positive relationships between internal service orientations of organization culture, absorptive capacity with servitization. It also shows that servitization has a positive impact on firm performance. It also highlights the role of learning specific capabilities within the manufacturing firm, the model shows how industry clock speed moderate the relationship between servitization and firm perfromace, in which manufacturing firms need to deploy strategies that respond to the ever evolving external environment, which in returns

enhance firm performance. This study extends earlier research on the relative role of service orientation of organizational culture and the internal risk assessment of the introduction of servitized offering. The findings of this study suggest that, the integrated model of servitization appears to be a powerful mechanism in efforts to enhance the performance of the manufacturing firms, particularly when manufacturing firms are operating competitive landscape.

In sum, the findings of this research answered to a large extent the four research questions presented in Chapter 1, helping to bridge some of the gaps in the existing discourse. To our knowledge, this is the first survey research to investigate servitization by using a large set of firm-level data to derive theoretical and practical implications with a high degree of objectivity.

This thesis opted to advance the servitization dialogue by providing systematic and robust evidence of the impact of servitization on firm performance, as well as by answering question that have remained controversial. Prior research has shown that many of the expected benefits of servitization (in terms of higher revenues or higher profitability, for instance) fail to materialize in many cases. This is called the “service paradox” (Gebauer, Fleisch, and Friedli, 2005). The present study provides empirical evidence of a positive relationship between servitization and firm performance.

The study’s findings imply that that servitization is not a dichotomous concept – i.e. servitized versus not servitized. Rather, servitization should be viewed as a multidimensional construct with different levels of capabilities and interactions between variables. This means that it is highly important to understand how manufacturers sense and look for new ideas, how they seize and assimilate new knowledge, how they plan for risk and contingencies, and how they co-create value with stakeholders. Some capabilities positively affect firm performance, while others do not. In general, servitization was shown to be a highly valuable strategy for manufactures. However, the results revealed that companies that are highly servitized show lower performance than those that are moderately servitized. Consequently, it is vital to look at how companies introduce different service offerings into to the marketplace and to understand that firms need to be very selective when

introducing complementary services. This can help in avoiding the service paradox, which was very obvious in our group analyses, and which can affect firm performance and value growth (Crozet and Milet, 2017).

The ramifications of the research findings with regard to the significant moderating effects are that they show that the impact of a firm's servitization strategies on firm performance is contingent and confounded by factors residing outside the company. In this sense, servitization can be expanded beyond a mere strategic choice introduced by management to enhance firm growth. Industry clock speed and the industry dynamism limit how manufacturers introduce servitization and whether they will benefit from service introduction. While industry clock speed can be used in management studies as a proxy for competition and the pace of change (Fang et al., 2008; Martinez et al., 2017), this research has shown that in a highly competitive industry, competing through services enhances firm performance by providing a source of differentiation and innovativeness (Baines et al., 2017).

6.4 Theoretical Contributions

This section highlights the theoretical implications of this research on the servitization literature and its related theoretical underpinnings. Overcoming the shortcomings of inductive reasoning, the study model was theoretically grounded and utilised appropriate theoretical frameworks (see Chapter 3), thus laying the groundwork for its contribution to the servitization field.

First of all, this thesis attempted to suggest some interacting mechanisms between firm level factors and industry factors. Thus, this thesis contributes to the RBV by providing more comprehensive evidence for this theoretical perspective, in which a company's strategic competitive advantage and performance are a function of complex inimitable resources that are embedded within the organization along with unique inputs and capabilities that adapt to the environmental changes (Barney, 1991; Peteraf and Barney, 2003; Hamel and Prahalad, 2010). In addition, the study has shown that the process of acquiring knowledge through absorptive capacity and organizational learning has

direct effects on servitization and firm performance, thus providing evidence that the usefulness of firm resources varies with changes in firm knowledge (Penrose, 1959). Finally, it can be concluded that the competitive advantage of a servitized manufacturing firm is dependent on its ability to achieve fit or coherence among a set of competitive factors, both internal and external to the firm. This in turn facilitates high performance. Manufacturing firms with high internal and external fit are likely to outperform those servitized manufacturing firm with less fit.

A second related contribution is that the study findings provide general support for the capability arguments put forth in the strategic management literature, complementing the dynamic capability theory (DCT), which is in fact an extension of the RBV theory. DCT posits that the learning process is a major source of value when building firm capabilities (Giniunienea and Jurksiene, 2015; Grant, 1996), emphasising the view of organizational learning as the operational process of obtaining information and converting it into knowledge (Franco and Haase, 2009). The dynamic capabilities approach also helps explain why intangible assets, including a firm's collective knowledge and capabilities, have become the most valuable class of assets in a wide range of industries (Lev, 2001; Hulten and Hao, 2008). The reason for this is that knowledge, capabilities and other intangibles are not only scarce – they are often difficult to imitate.

As suggested by our findings, servitization also help firms to renew competencies so as to achieve congruence with the changing business environment (Winter, 2006). As such, it can be viewed as a potential strategy for growth and sustained profitability in highly competitive markets riddled with deep uncertainty (Teece, 2017).

Furthermore, this research highlights the importance of recognizing that capabilities such as asset orchestration and market co-creation are vital to resource allocation within manufacturing firms (Katkalo, Pitelis, and Teece, 2010).

In this thesis, the author paid considerable attention to organizational learning and knowledge absorption from partnerships and strategic alliances, which requires continued renewal of resources, reconfiguring them as needed to innovate and respond to customer needs (Pisano and Teece, 2007; Teece et al., 1997). The study findings also add to previous empirical research on the role of learning specific capabilities, which has focused on the analysis of the transaction costs and mechanisms for earning rents from such relationships (Dyer & Hatch, 2006).

The ability of manufacturers to create dynamic business models through servitization and its integration mechanisms constitutes the ultimate source of competitive advantage (Takeuchi, 2006; Spanos and Lioukas, 2001). While the importance of value co-creation in advancing servitization has been recognized in the servitization literature (Kohtamäki et al., 2013), empirical work on value co-creation and its impact on firm outcomes in a servitized context has remained very limited. The present study extends the literature by demonstrating how value co-creation impacts servitization and its interaction with firm learning processes and firm performance.

In addition to the aforementioned theoretical contributions, this thesis also has a great contribution that will help advance industrial service research in the future. This contribution is the development and the empirical validation of a multidimensional scale for assessing servitization. To our knowledge, our study is one of the first attempts to do so. Our servitization construct significantly advances the existing dimensions of servitization by including management's cognitive ability to understand the benefits of servitization, the importance of mobilizing firm resource, and market offering modes. The new scale was validated and empirically tested for its content validity and reliability (see Chapter 5), and by testing this scale across a wide range of industries, the author has shown that it provides a fair degree of generalizability. Table 6-1 summarizes the study's key implications for servitization discourse.

Table 0-1: Implications for the servitization discourse

Space addressed	Principal points
Ontology of servitization	Servitization is a strategy involving business model change and novel tactics. Servitization is a strategy involving selective repositioning in the value chain, upstream and/or downstream.
Typology of servitization	There i**s** more than one way for a manufacturer to servitize. At least four conceptually distinct servitization modes are identified: product, process, operational and platform-centric servitization.
Enablers of servitization	The main enabling factors, as empirically demonstrated, are service orientation of organizational culture, value co-creation, and absorptive capacity.
Barriers to servitization	Organizational risk, financial risk, customer acceptance risk, supply chain risk, and market barriers
Structure of servitization literature	The existing body of knowledge would profit from using a more rigorous deductive approach, model building and confirmatory approaches that promote the research agenda beyond the descriptive and conceptual state
Servitization dimensions	Top management service orientation, resource mobilization, and the market offering

Finally, while some research has focused on the servitization–firm performance relationship, the mechanisms by which servitization affects firm performance remain underexamined. Therefore, the model developed in this thesis can serve as a basis for evaluation of servitization performance. The theoretical contribution of this research can be extended to include the establishment of a new conceptual servitization model dedicated to exploring the determinants of servitization in manufacturing context.

6.5 Managerial Implications

This thesis finding gives a deep insight into the implantation of servitization within manufacturing firms, this research dwells on the major antecedents of servitization and firm performance, the study framework provides some pivotal management guidelines for further development of servitization in manufacturing. The result of this research have some implications for decision makers where servitization is concerned.

Furthermore, from a pragmatic standpoint, this research makes several contributions to practice. However, before articulating these practical implications, it is important to stress that the findings presented here should be viewed as preliminary evidence regarding servitization practice. Therefore, further research should be encouraged to both refine the study constructs and their measures, and also to test the model with other data, before definitive guidelines for practitioners can be derived. Nevertheless, as highlighted by Story et al. (2016), servitization has implications for various stakeholders, and the research findings substantiate our conceptual model and offer several managerial implications.

6.5.1 Enhancing Service Capabilities

Nowadays, decision makers in manufacturing firms are facing new challenges from the high pace of dynamic market environments. Thus, they often face the question of whether and how to pursue a servitization strategy to avoid the 'commoditization trap,' achieve higher performance, enhance customer experience, and to spur and sustain competitive advantages.

The shift to data-driven, customer-centric business models that consider service infusion and innovation as core capabilities can be enhanced by better management orientation toward identifying challenges facing their industries and how such challenges can affect the servitized market offering.

Our findings highlight the importance of the firm's service capabilities for enhancing the synergy between learning capabilities and servitization initiatives; this will allow servitization to have better impact on firm performance. Prior investment into organizational resources, skills, and capabilities was one of aspects that the study's participants agreed as the most important, in fact our research shows that value co-creation is the most important aspect for composing value chain, from research and development to after-sales.

The study also provides further evidence that the key to achieving sustainable business performance does not lie directly in the type of organizational structure that managers set up for the

service business, but in the increase in service orientation in the organizational culture (Gebauer et al., 2008). Therefore, the right implementation of routines and education to support a service culture must occur.

An instructive managerial implication rests in the finding that industrial service providers engaged in servitization must develop service infusion capabilities and, more importantly, ensure that their portfolio includes the skills needed to handle the transition to a customer-centric business model, while introducing the right performance measurement system to assess the services provided (Gounaris and Venetis, 2002).

Another good managerial insight lies in prioritizing the antecedents of servitization strategies, looking at how a micro-analytic exercise linking these antecedents with problem solving can help in creating a better customised servitized solution. Furthermore, mangers should view increasing levels of industry competition as an opportunity to diversify and differentiate through services – a strategy that has been shown to be a good strategic move that leads to better performance (Lumpkin and Dess, 2001).

6.5.2 Leverageing Strategic Alliances and Partnerships between Stakeholders

In manufacturing context, the need to build and maintain strategic alliances and partnerships between different stakeholders is considered paramount to acquire new innovative solution and latest manufacturing capabilities that serve the servitized offerings and help maintain firm performance in a cost effective way to safeguard the firm position from competition.

While it is unquestionable that firms should strive to design their servitized offers to perfectly match their customers' needs, firms must also take into account the importance of opening the firm to external innovative ideas. Therefore, they should invest in measures that increase the efficiency of internal R&D, external outsourcing processes, and strategic industry partnerships, which in returns

increase the barriers to entry. Doing so requires a special breed of mangers with the ability to manage across the firm's silos and outside firm boundaries (Teece, 2017).

While manufacturing environment marked with fierce competition, the strategic shift to service provision can be challenging, therefore this study finding suggest that managers should actively compare the actual progress of their servitization strategies against pre-developed key performance indicators KPIs, bearing in mind that it is a sequential process in which knowledge acquisition initiatives inform servitization design and implementation. It is also important to understand that growth potential cannot be realized without sufficient human capital, knowledge transfer and proper investment into capability renewal.

Yet another important aspect that is considered the cornerstone of servitization is the contractual part of the market offering (Batista et al., 2017). Trusting relationships are a key factor in the performance of contracts; establishing such relationships requires the right governance structures to preserve the functional viability of the system and diminish any risk and uncertainty in the new relationship (Coleman, 1988).

6.5.3 Introducing Services Enhance Firm Performance

Many of this thesis findings provide guidance to managers and consultants who are engaged in implementing servitization in firms. It is paramount to have a clear servitization strategy to achieve the desired performance outcomes; this is a prerequisite for ensuring financial soundness and also achieving significant potential for value creation. As the findings suggest, the mediating role of servitization clearly highlights how, in uncertain environments, servitization and absorptive capacity can be leveraged as a source of sustainable competitive advantage; thus, mangers must pay more attention to this relationship.

To be achieve financial success, the implementation of service technologies must be treated as a business initiative (Smith and Milligan, 2002). Our findings show that top management

commitment and vision significantly foster servitization (Antioco et al., 2008). It is also argued here that servitization strategies must be linked to proper reward and incentive system in manufacturing firms. Nonetheless, most manufacturing incentive systems remain liked to R&D and operations, and revolve around the core product offering.

From a managerial point of view, the author provides empirical evidence that industrial services can help manufacturing companies enhance their bottom line. However, our findings also indicate that industrial service offerings will not automatically improve a company's financial and market position. Rather, the performance outcomes of service provision depend on the context the firm operates in and the pace of industry change. Our results also indicate that service managers should clearly understand the strategic thrust of the organization and institute mechanisms to ensure that learning capabilities are channelled toward areas that are important to the organization's servitization strategy.

Finally, it can be concluded that the empirical validation of the study's integrative model will help in implementing the right "means" to creating a positive performance impact from servitization. This is because the model articulates some important managerial actions and tools for advancing and implementing servitization by adjusting managerial practices in a goal-oriented manner. In addition, the servitization measurement scale introduced in this thesis can serve as a step towards the development of a prescriptive management tool to assess service capabilities and infusion inside the firm.

6.6 Research Limitations and Future Directions

Despite the significant theoretical and pragmatic contributions of this thesis, the choice of empirical setting –the deductive approach- raises some theoretical and methodological issues, and also points to important avenues for future research.

First, from a methodological point of view, the study may be limited by being structured around a cross-sectional survey research design. Because of this, the cause–effect relationships between constructs in the model must be viewed with caution. Although the author has established associations between the causing and the caused constructs statistically, the sequential relationships between the constructs were argued for based on existing theories. Consequently, the author acknowledges that the only rigorous method for testing causal relationships among constructs is through longitudinal studies. In this thesis, the author reasoned the SBM model using theoretical arguments.

While the longitudinal approach has many benefits, it was not possible here due to practical considerations. Similarly, it is also recognised that the study could profit from the benefits of a formal case study approach. The absence of such an approach, however, was offset by the consideration of extensive archival information in conjunction with verbal correspondence and informal meetings with a significant number of the survey informants.

Second, as mentioned previously, the constructs that compose the model are represented as latent variables that are not directly observable. Therefore, they are measured using indicators. The issue is that a large number of indicators can reflect a construct, and given the constraint of survey length, it is plausible that this thesis may not have sampled all items from a construct's domain. However, our sampling and inclusion criteria were based on a structural approach, where the author aligned the construct indicators with our conceptual definitions to develop the measurement scales. Recognizing this limitation, future research might refine our conceptual definition, operationalization and measurement scale for the servitization construct by including other items that might prove relevant to establishing the robustness of our results.

Third, in spite of multiple sources have been used to collect this thesis's data as an effort to triangulate our data, the author still acknowledge that better data triangulation is needed to further support the study results.

Fourth, the stability of the relationship between servitization and firm performance over time remains an untested area deserving of attention. This could be accomplished by using longitudinal data to further test the results of this thesis and further confirm the causality claim.

Fifth, this thesis has emphasized insights derived from the RBV and dynamic capabilities literature. However, a number of other theoretical perspectives address the contingencies influencing organizational performance; this is an area that might stimulate additional empirical research.

Sixth, for cross-cultural/cross-national research, measurement equivalence is an important methodological issue (Malhotra and Sharma, 2008). As some of the countries were represented by very few participants in our sample (e.g., Sweden and Switzerland), the author refrained from performing a measurement equivalence assessment using either a multi-country CFA or the generalizability theory approach (Shavelson and Webb, 1991). Hence, the author considers this shortcoming to be a rich new avenue for future research.

Seventh, in this thesis industrial services were considered a homogeneous offering, and therefore a more fine-grained study is important in order to shed the light on the heterogeneity of service offerings from manufacturing firms and the differential effects of various offerings on firm performance.

In terms of future research opportunities, this thesis's results put forward a number of areas for management scholars to study. First, research can look at how some forms of servitization are more accessible to particular manufacturing firms due to differences in digital capabilities. It is possible that some manufacturing firms can become better at creating specific servitized offers as they become more adept at integrating digital technologies, communicating and breaking down market and customer needs.

Second, while this thesis has focused on eight relatively broad constructs to anchor the proposed theoretical framework, manufacturing firms are constantly seeking innovative

configurations of different dynamic capabilities, communication channels, incentives, intellectual property (IP), property rights and other intellectual assets that mirror the high-powered incentives of markets (Foss, 2003). Therefore, complex theoretical models could be developed building on the aforementioned factors that might influence servitization implementation.

The ever-evolving body of research concerning servitization and industrial marketing provides rich ground for future research. Thus, a third main opportunity lies in investigating the micro-foundation of the servitization business model using wider firm-level considerations. In other words, the author has treated servitization as a straightforward process, but manufacturing firms are typically engaged in a wider set of activities that are considered core to their business, and most certainly mangers in reality engage with a combination of firm-level problems related to business model innovation. This is especially true in a servitized context due to the multifaceted nature of the offering, which in turn generates more complexities in the managerial problem sphere that need to be treated with caution. Therefore, there are many pitfalls associated with servitization adoption that can lead to unwanted consequences (Benedettini et al., 2015). This issue also deserves attention in future research. Challenges facing digitalization and servitization in terms of cybersecurity and governance can have an impact on firm performance (Huxtable and Schaefer, 2016); these issues provide another interesting line of inquiry.

Recently, scholars have begun to challenge the assumptions about service-oriented growth strategies in manufacturing, and have pointed out the importance of balancing business expansion with standardization activities (Kowalkowski et al., 2015). A recent conceptualization suggested that information can be a third dimension, alongside services and products, and that the value of big data can be utilized in servitization (Opresnik and Taisch, 2015). Following this line of inquiry, the role of technological trajectories in advancing servitization, the internet of things (IOT) and digitization is another interesting avenue for further research.

Future research should also continue to investigate the means through which manufacturing firms can facilitate higher levels of productivity through servitization. For instance, are there specific types of resources (i.e., human, social, technological, etc.), organizational contexts (internal, external, strategic, etc.), managerial cognitive abilities or additional capabilities that serve to influence firm performance, and with what effects? Moreover, considerations beyond resource orchestration capabilities that may influence the temporal lag between when resource costs are incurred and benefits are realized by firms should be explored in future research.

Finally, adjacent literature streams from the fields of strategy, organizational change and marketing, which have long dealt with issues that servitization touches upon, could potentially be fruitful sources of insight, inspiration and future proposition-building.

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APPENDIX A

Study Questionnaire

Statement of Voluntary Consent

To participate as a subject in the study described below
Date: February 2016

Name of Study: Antecedents of Servitization Strategies in Manufacturing Firms and Servitization's Impact on Firm Performance. A Theoretical and Empirical Analysis

I am currently undertaking my doctoral thesis at the Claude Littner business school of the University of West London in England.

Purpose of Study: Increasing the understanding of the current servitization strategies in manufacturing firms and their transition to service provision, especially the impact of servitization on firm performance.

In essence **servitization** is a transformation journey - it involves firms (often manufacturing firms) developing the capabilities they need to provide services and solutions that supplement their traditional product offerings.

As a volunteer participant in the above mentioned research, I understand that I will be asked to complete a survey that will ask questions related to my company servitization strategies. The survey typically takes about 10 to 15 minutes to complete. The information I provide will be used exclusively for this project and will in no way be associated with my name, address or any other identifiable information. I understand that I may withdraw from this study at any time and that any data given will not be used.

The participant right to confidentiality will be always respected and any legal requirements on data protection will be adhered to. As well as data gathered will be stored securely and only used in anonymised and cumulative form for the purposes outlined above. After this research draw to close, the data will be destroyed.

All participating companies will receive a collective results report once the data analysis process is complete. The results will, among other things, allow you to see the impact of servitization strategies on firm performance across many industries.

This research is not funded by any corporate organization and does not represent any interests in any industry.

I fully recognize that the survey requires the sacrifice of valuable time on your behalf, and I deeply appreciate your attention and contribution.

For any clarification or inquiry, I remain at your disposal.

Primary Researcher(s): Mohamad AbouFoul

Contact Information: Mobile number: 07424045470,

Email address: 21301247@student.uwl.ac.uk

Part (1)

1) **Company Name:**----------

2) **Gender** ☐Male ☐female

3) **Your position in the company**

☐CEO
☐Service Manager
☐Head of marketing
☐Head of operations
☐Others: (please specify)----------

4) **Are you in the top management team of the company? ☐Yes ☐No**

5) **Please specify the number of years of working experience in the current industry:**

☐0-2 years
☐2-5 years
☐5-10 years
☐10-15 years
☐More than 15 years

6) **Please specify the total of years in your current position:**

☐0-2 years
☐2-5 years
☐5-10 years
☐10-15 years
☐More than 15 years

7) **Indicate your highest level of education**

☐High School Education
☐Bachelor's Degree
☐Master's Degree
☐Professional Degree
☐Doctorate Degree
☐Others: (please specify)----------

8) **Number of employee in the company 2017**

☐Less than < 10
☐Between 10 and 49
☐Between 50 and 249
☐More than 250

9) Annual sales (Turnover in Millions £)

☐Less than <2
☐Between 2 and 10
☐Between 10 and 50
☐More than 50

10) Company sector (please specify your prevailing activity, Please choose ONLY one).

	US SIC	Industry
	7.	Mining of metal ores
	10.	Manufacture of food products
	18.	Printing and reproduction of recorded media
	19.	Manufacture of coke and refined petroleum products
	20.	Manufacture of chemicals and chemical products
	21.	Manufacture of basic pharmaceutical products and pharmaceutical preparations
	22.	Manufacture of rubber and plastic products
	23.	Manufacture of other non-metallic mineral products
	24.	Manufacture of basic metals
	25.	Manufacture of fabricated metal products, except machinery and equipment
	26.	Manufacture of computer, electronic and optical products
	27.	Manufacture of electrical equipment
	28.	Manufacture of machinery and equipment
	29.	Manufacture of motor vehicles, trailers and semi-trailers
	30.	Manufacture of other transport equipment
	32.	Other manufacturing

11) Please specify the percentage share of services of total sales in 2016

☐0 %
☐Between 0% and 10%
☐Between 10% and 20%
☐Between 20% and 30%
☐More than 30%

12) Do you have a standalone service unites: ☐Yes ☐No

13) Some of our services can be purchased separate from our products: ☐Yes ☐No ☐Not applicable

14) What is the age of your company?

☐Between 0-5
☐Between 6 and 9
☐More than 10

15) Are you participating in designing and implementing sertvitization strategies? ☐Yes ☐No

Part (2)

Section (1)

For each statement, show the extent of your agreement by selecting the box that reflects your current view of your expectation as a whole.

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Somewhat agree (4)	Agree (5)	Strongly agree (6)
Our firm has taken over some of our customers' business processes.						
Our firm has taken over the operational functions of our products in customers' businesses.						
Our service contracts related to our products are designed to share 'risk and reward' with our customers, so our customers pay for the product's capabilities, outcomes and results.						
Our employees don't understand the benefits of building long-term relationships with our customers.						
The organization is investing in the necessary skills and capabilities to provide servitized offerings.						
Our business cases and key performance indicators are linked to our roadmap.						
Our firm continuously innovates its internal capabilities and processes to deliver new services with our products.						
Our firm strategy is to build an industry platform to integrate suppliers and customers.						
Our firm offers depend on the modularity of services and products.						

Our firm delivers non-standardized service modules that reflect the requirements of the products we supply.						
We help our customers to change their business model.						
Our senior leaders are aligned around the strategic importance of servitization transformation.						
Our senior leaders are actively promoting a vision of the future that involves servitized offerings.						
We regularly review with the top management team our progress on servitization transformation.						

Section (2)

For each statement, show the extent of your agreement by selecting the box that reflects your current view of your expectation as a whole.

We have the capability to….	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Somewhat agree (4)	Agree (5)	Strongly agree (6)
The search for relevant information concerning our industry is everyday business in our company.						
We develop new product/service by using assimilated new knowledge.						
We develop new applications by applying assimilated new knowledge.						
We find alternative uses for assimilated new knowledge.						
We revise manufacturing/service processes based on acquired new knowledge.						

We introduce product innovation based on acquired new knowledge.						

Section (3)

For each statement, show the extent of your agreement by selecting the box that reflects your current view of your expectation as a whole.

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Somewhat agree (4)	Agree (5)	Strongly agree (6)
Our firm tailors its product/service to our client's needs.						
Our customer's comments and concerns are highly valued by our firm.						
Our firm is responsive to its customer's needs.						
Our firm offers a non-standardized level of service to its customers.						
Our client/end users are usually involved in the process of new product/service development.						
Our products/services are usually developed in light of customer/client wishes and suggestions.						
In order to acquire new know-how/technology we cooperate with our customers/clients (Never/Always).						

Section (4)

For each statement, show the extent of your agreement by selecting the box that reflects your current view of your expectation as a whole.

	Low (1)	Medium (2)	High (3)
In our industry the change in customer preferences is….			
The change in our competitive situation is ….			
In our industry the technological change is ….			
The change in our firm structure is ….			
In our industry the rate of new product/service introduction to market is ….			

Section (5)

For each statement, show the extent of your agreement by selecting the box that reflects your current view of your expectation as a whole.

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Somewhat agree (4)	Agree (5)	Strongly agree (6)
There is a risk that the financial cost associated with servitization may outweigh the benefits.						
The performance of the solution we provide may not meet our customer's expectations.						
There is a risk that we will not be able to acquire the new capabilities needed to deliver the new solution.						
There is a risk that our contract partner will be unable to fulfil contractual agreements.						
The decision to implement servitization in our firm is very risky.						

Section (6)

For each statement, show the extent of your agreement by selecting the box that reflects your current view of your expectation as a whole.

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Somewhat agree (4)	Agree (5)	Strongly agree (6)
Services are one of the core values of our corporate culture.						
Our employee values are centred on solving customer problems.						
Employees are aware of the importance of comprehensive and high-quality services and they act accordingly.						

Section (7)

For each statement, show the extent of your agreement by selecting the box that reflects your current view of your expectation as a whole.

	Not at all (1)	To a small extent (2)	To some extent (3)	To a moderate Extent (4)	To a great extent (5)	To a very great extent (6)
To what extent is your company engaging directly with lead users and early adopters?						
To what extent is your company participating in open source software development?						
To what extent is your company exchanging ideas through submission websites and idea "jams" or idea competitions?						
To what extent is your company participating in or setting up innovation networks/hubs with other firms, or sharing facilities with other organisations, inventors, researchers, etc.?						
To what extent is your company involved with joint R&D?						
To what extent is your company involved in joint purchasing of materials or inputs?						
To what extent is your company involved in joint production of goods or services?						

To what extent is your company involved in joint marketing/co-branding?						
To what extent is your company participating in research consortia?						
To what extent is your company involved in joint university research?						
To what extent is your company licensing externally developed technologies?						
To what extent is your company involved in outsourcing or contracting out R&D projects?						
To what extent is your company providing contract research to others?						
To what extent is your company involved in joint ventures, acquisitions and incubations?						

Section (8)

For each statement, show the extent of your agreement by selecting the box that reflects your current view of your expectation as a whole.

Compared to our competitors, In the past 3 years our…						
	Strongly decreased (1)	decreased (2)	Somewhat decreased (3)	Somewhat increased (4)	Increased (5)	Strongly increased (6)
Sales growth						
Return on asset (ROS).						
Return on sales (ROS).						
Return on investment (ROI).						
Market value.						
General profitability.						
Over all firm performance.						
Entering new markets.						
Customer satisfaction.						
Speed to market.						
Product/service quality.						
Success rate for new product and service introduction.						
Percentage of new products/services in the existing product/service portfolio.						
Market share.						

Please specify your knowledge about this survey area

☐Low knowledge
☐Moderate knowledge
☐High knowledge

Many thanks for answering the questions!!

APPENDIX B

Firms Business Description

Example of servitized firms business description OSIRIS database

Siemens AG is a technology company with activities in the fields of electrification, automation and digitalization. The Company is also a supplier of systems for power generation and transmission, as well as medical diagnosis. It operates through nine segments: Power and Gas; Wind Power and Renewables; Energy Management; Building Technologies; Mobility; Digital Factory; Process Industries and Drives; Healthineers, and Financial Services. The Company's product groups include automation, building technologies, drive technology, healthcare, mobility, energy, financing, consumer **products and services**. Its services include industry services, energy services, healthcare services, rail and road solutions services, logistics and airport solutions services, home appliances services, and building technologies services. Its market-specific solutions are focused on markets, such as aerospace, automotive, data centers, fiber industry, food and beverage, and machinery and plant construction.

3M Company is a technology company. The Company operates through five segments. Its Industrial segment serves markets, such as automotive original equipment manufacturer and automotive aftermarket, electronics, appliance, paper and printing, packaging, food and beverage, and construction. It's Safety and Graphics segment serves markets for the safety, security and productivity of people, facilities and systems. Its Health Care segment serves markets that include medical clinics and hospitals, pharmaceuticals, dental and orthodontic practitioners, health information systems, and food manufacturing and testing. It's Electronics and Energy segment serves customers in electronics and energy markets, including **solutions** for electronic devices; electrical products; telecommunications networks, and power generation and distribution. Its Consumer segment serves markets that include consumer retail, office business to business, home improvement, drug and pharmacy retail, and other markets.

Example of not servitized firms business description

Nabaltec AG is a Germany-based company that develops, manufactures and distributes functional fillers for the plastics industry and raw materials for technical ceramics. The Company operates through two segments: Functional Fillers and Technical Ceramics. The Functional Fillers segment develops, produces and distributes halogen-free, flame retardant fillers on the basis of aluminum hydroxide und the APYRAL trade name, as well as on the basis of magnesium hydroxide, under the APYMAG brand. The Technical Ceramics segment produces calcined aluminum oxides and sintered mullites, as well as complete ceramic bodies. In addition to that, the Company also performs chemical and physical tests for inorganic raw materials and technical materials, mineral raw materials, mineral- or ceramic-bound construction materials and inorganic binding agents, plus the analysis of geological samples, filter dusts and fly ashes.

Allied Motion Technologies Inc. designs, manufactures and sells precision and specialty motion control components and systems used in a range of industries. The Company serves various markets, including vehicle, medical, aerospace and defense, electronics and industrial. It focuses on motion control applications. It is engaged in developing electro-magnetic, mechanical and electronic motion technology. It operates in the design and manufacture of motion control products, marketed to original equipment manufacturers and end users segment. Its products are used in the handling, inspection, and testing of components and final products, such as printers, tunable lasers and spectrum analyzers for the fiber optic industry, and test and processing equipment for the semiconductor manufacturing industry. Its products are used in a range of medical, industrial and commercial aviation applications, such as dialysis equipment, industrial ink jet printers and cash dispensers.

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