Master Thesis

Rapid Prototyping-as-a-Service: Pricing Strategies in Industrial Markets

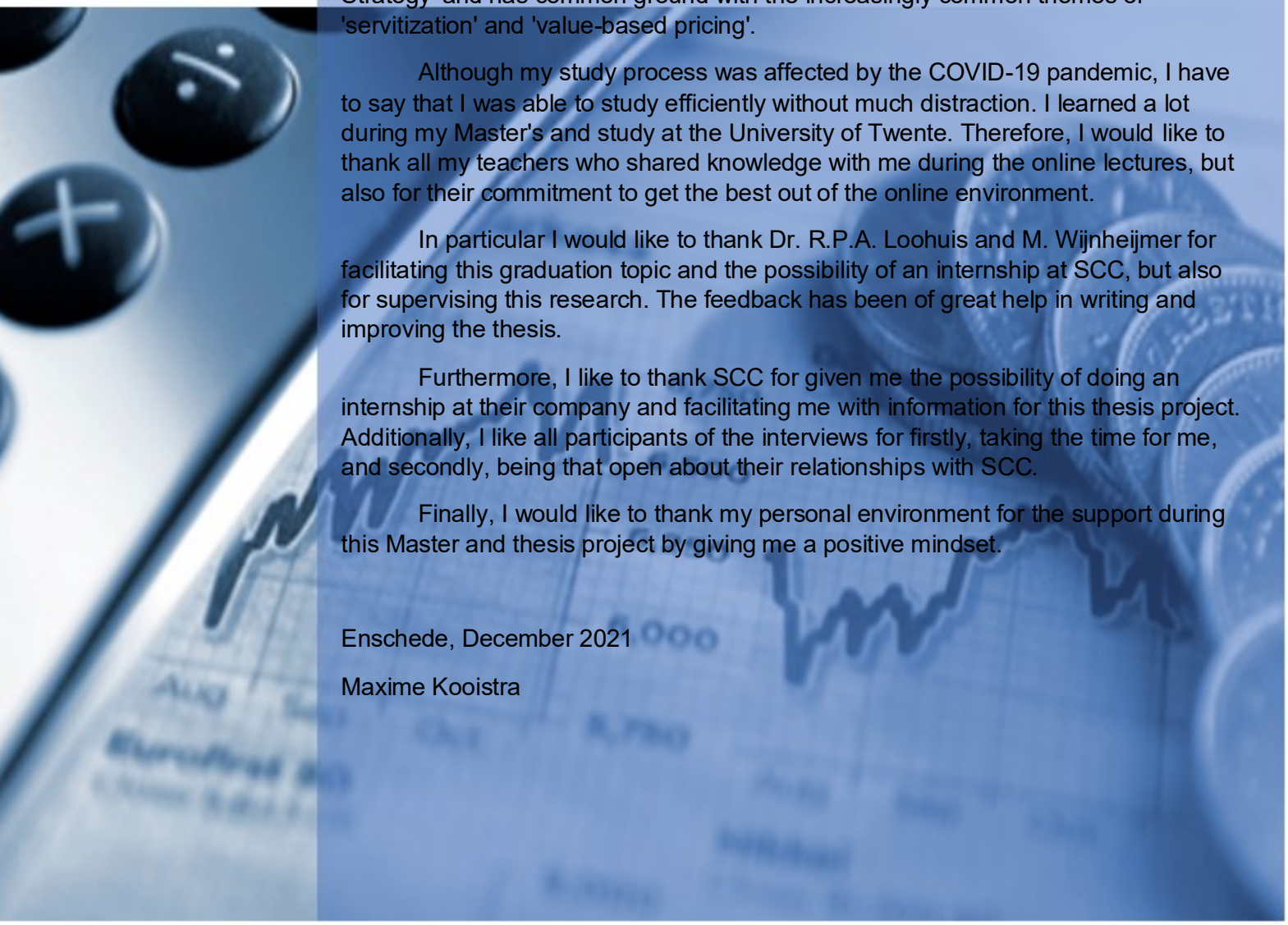
Maxime Kooistra
(s2566761)

MSc in Business Administration; Entrepreneurship, Innovation, & Strategy
Faculty of Behavioural, Management and Social Sciences, University of Twente

Supervisors: Dr. R.P.A. Loohuis, Drs. P. Bliek

December 6, 2021

UNIVERSITY OF TWENTE.



Acknowledgements

This thesis was written in the context of graduating from the Master of Business Administration at the University of Twente. Personally, I was looking for the connection between the theoretical knowledge and scientific literature offered at the university and a real case of a company, so it was a great opportunity to conduct this research on behalf of Special Casting Components Ltd (SCC). In addition, this research ties in with the specialization track 'Entrepreneurship, Innovation and Strategy' and has common ground with the increasingly common themes of 'servitization' and 'value-based pricing'.

Although my study process was affected by the COVID-19 pandemic, I have to say that I was able to study efficiently without much distraction. I learned a lot during my Master's and study at the University of Twente. Therefore, I would like to thank all my teachers who shared knowledge with me during the online lectures, but also for their commitment to get the best out of the online environment.

In particular I would like to thank Dr. R.P.A. Loohuis and M. Wijnheijmer for facilitating this graduation topic and the possibility of an internship at SCC, but also for supervising this research. The feedback has been of great help in writing and improving the thesis.

Furthermore, I like to thank SCC for given me the possibility of doing an internship at their company and facilitating me with information for this thesis project. Additionally, I like all participants of the interviews for firstly, taking the time for me, and secondly, being that open about their relationships with SCC.

Finally, I would like to thank my personal environment for the support during this Master and thesis project by giving me a positive mindset.

Enschede, December 2021

Maxime Kooistra

Abstract

Aim of study

The aim of this study is to come up with a pricing strategy for different customer segments that is suitable for Rapid Prototyping (RP) for the company Special Casting Components Ltd (SCC). As a technology, RP can be used to rapidly produce products to improve the design, engineering and series production process and thereby to reduce costs. The popularity of RP techniques is growing rapidly but many manufacturers offer it to ensure that they sell machines and components. This way of thinking does not do justice to the value RP offers to the firm and the customers. Therefore, it is of importance to investigate what prices can be asked and what the associated customer value is for RP as a service offered next to other business offerings. This research aims to facilitate insights for a possible value-based pricing (VBP) strategy for SCC's RP, and is of practical relevance for other manufacturing companies to position RP and related technology in a rightful and valuable way to their customers.

Methodology

The research design of this thesis is a combination of academic literature and qualitative exploratory research. Firstly, backgrounds of RP techniques are studied and VBP theories with associated aspects are discussed. Moreover, to define the customer value related to RP, an analysis is conducted based on the influence of new technologies, value-in-use and habits in the market. This analysis is the first step of a defined VBP framework that later is used to implement a VBP strategy for SCC. Secondly, a multiple case study is executed using SCC's customers in different markets. These customer industries reflect a variety of customer values and as a consequence might need a different VBP approach. Data from SCC's customers is collected by interviews. Additionally, information is collected from SCC's sales and management team to get insights in current pricing of RP and to compare whether SCC is responding to customer values in the right way. All this data is used in the VBP framework to assess SCC's current RP pricing and to implement a VBP strategy for RP.

Results

This research has identified distinctive value propositions for different customer segments based on their customer values. Besides this, different strategies are formulated for RP based on value-in-use, habits in the market, alternative techniques for RP and the influences of new technologies.

At the start of this research, two value propositions related to RP were identified: Rapid Prototyping-as-a-Service (RPaaS) and Rapid Prototyping-as-a-Product (RPaaP). Based on the results from this research, it is advised to reframe these value propositions from 'inside-out solution focused' to an 'outside-in promise of a result', by emphasizing that SCC is the partner of choice if a customer wants an optimized series design which results in the lowest TCO. Based on that insight, the advised VBP strategy for RP is to embed it in a broader 'Optimization-as-a-Service' proposition, highlighting the value of lost wax casting as a technique and the differentiating value offered by SCC as a leading supplier. In this way RP contributes to SCC's core business.

Implications

Based on literature, this research analyses customer values for different industries based on a predefined framework. Further, this research defines value propositions for the distinctive customer segments and creates a VBP framework that also can be applied to implement VBP strategies in other manufacturing or B2B companies. Additionally, this research proposes practical implications for SCC's website, quotation structure, and presents a sales tool that could be used for the implementation of RPaaS. Finally, this research contributes to academic literature knowledge about practical implications for VBP strategies and identifies the complexity of monetizing the customer values due to high customization rates. To summarize, this research creates a process for price optimization of SCC's RP.

Future research

To validate the insights of this research, further research is necessary. For instance, data collection methods are limited, due to the time frame of this research. So, more extensive data collection could improve insights into RP values and pricing practices. This could be done by conducting a Voice of Customer (VOC) research. Additionally, the best alternative techniques of RP could be investigated in more detail. Furthermore, the pricing tools and strategies of this research are not yet tested in practice, so assessment criteria should be formulated to effectively assess and improve the VBP strategy. Additionally, more research is necessary to the quantification of RP's value by using, for instance, total costs of ownership (TCO) analysis or benchmarks. And finally, this research is conducted on behalf of SCC, this means that results and customer values are case specific and not generalizable. In conclusion, to test the usability of the 'pricing strategy framework', more research is needed within other companies.

Table of content

Acknowledgements 2
Abstract 3
Table of content 5
Table of content 7
Chapter 1: Introduction 8
1.1 Situation and complication 8
1.1.1 Introduction to the case firm; the component manufacturer 8
1.1.2 Rapid Prototyping research 8
1.1.3 Rapid Prototyping pricing 8
1.2 Research objective 9
1.3 Research questions 9
1.3.1 Sub research questions: 9
1.4 Methodology 10
1.5 Relevance 10
1.6 Overview 10
Chapter 2: Theory 11
2.1 An overview of Rapid Prototyping 11
2.2 Value-based pricing strategies 12
2.2.1 Value propositions 12
2.2.2 Customer value 13
2.2.3 Perceived value and quality 13
2.2.4 Voice of Customer 14
2.2.5 Quantification of value 15
2.2.6 Total Costs of Ownership 16
2.3 Factors that influence value-based pricing strategies 16
2.3.1 Habits in industrial markets 16
2.3.2 New technologies in industrial markets 17
2.3.3 Servitization 17
2.4 Framework to define VBP for RP 18
2.5 Conclusion 20
Chapter 3: Research design 21
3.1 Case study 21
3.2 Multiple methods 21
3.3 Data collection methods 22
3.3.1 Literature review 22
3.3.2 Online review 22

3.3.3 Customer interviews ... 22
3.3.4 Group discussion & focus groups ... 24
3.4 Trustworthiness ... 24
3.4.1 Consistency & neutrality ... 25
3.4.2 Truth value ... 27
3.4.3 Applicability ... 27
3.5 Planned data analysis ... 28
3.5.1 Operationalization table ... 29
Chapter 4: Results ... 31
4.1 Pricing practices and value creation at SCC ... 31
4.1.1 SCC's vision on Rapid Prototyping and its value ... 31
4.1.2 SCC's current Rapid Prototyping pricing ... 32
4.2 Pricing habits in the component manufacturing market ... 33
4.3 Value-based pricing framework – Customer identification and analysis ... 33
4.3.1 Customer segmentation ... 33
4.3.2 Customer value analysis ... 38
4.3.3 Value proposition development ... 41
4.4 Value-based pricing framework – Implementation ... 41
4.4.1 Fostering trust and building reputation ... 42
4.4.2 Value creation and communication ... 43
4.5 Value-based pricing framework – Verification of value ... 45
4.5.1 Quantification and value assessment ... 45
4.5.2 Value capture ... 47
4.5.3 Knowledge management ... 48
4.6 Conclusion ... 48
Chapter 5: Discussion ... 49
5.1 Value Proposition of Rapid Prototyping-as-a-Product: ... 49
5.2 Value Proposition of Rapid Prototyping-as-a-Service: ... 49
5.3 Practical implications for value-based pricing strategies ... 50
5.4 Practical implications of this research ... 50
5.5 Theoretical implications of this research ... 51
5.6 Research limitations and further research ... 51
Reference list ... 53
Appendix 1: The new rules of purchasing in B2B markets ... 56
Appendix 2: Identified capabilities for Value-based pricing and selling ... 57
Appendix 3: Value-based pricing capability development ... 58
Appendix 4: Interview protocol and questions ... 59

Appendix 5: Case study protocol 62
Appendix 6: Coding results from interviews 64
Appendix 7: Value proposition formula 68
Appendix 8: SCC's Current quotation structure 69
Appendix 9: Online Review 71
Appendix 10: Customer's price experiences 77
Appendix 11: Value analysis based on SCC's own perspectives 80

Table of content

Table 1 Three types of value propositions (Anderson et al., 2006) 13
Table 2 Online Review Search Terms 22
Table 3 Interview Protocol 23
Table 4 Overview of sampled interviews and data collection 23
Table 5 Qualitative vs. quantitative research approaches (Yulianto & Krefting, 1991) 24
Table 6 Strategies to establish trustworthiness in qualitative research 25
Table 7 Case Study Protocol (Baškarada, 2014) 26
Table 8 Operationalization table 29
Table 9 Customer segmentation based on interview results 36
Table 10 Value-in-Use of Rapid Prototyping 38
Table 11 Arguments for strategic relationships with SCC 38
Table 12 Benefits and drawbacks of additive manufacturing techniques according to Duda & Raghavan (2016) and Gadagi & Lekurwale (2020) 39
Table 13 Scoring card for RP in comparison to 'alternative techniques' 40
Table 14 Price ratio of the RP parts and wax injection mold price 44
Table 15 Value-based pricing sales tool for SCC's Rapid Prototyping 47

Figure 1 "Conceptual framework for customer assessment of value-in-use" (Macdonald et al., 2008, p. 673) 14
Figure 2 Framework of 'willingness to buy' (Hinterhuber, 2004) 15
Figure 3 Framework to define VBP for RP 19
Figure 4 Customer segmentation of interview respondents 37

Chapter 1: Introduction

1.1 Situation and complication

1.1.1 Introduction to the case firm; the component manufacturer

This research is carried out on behalf of 'Special Casting Components Ltd' (SCC). SCC has introduced a new product-market combination 'Rapid Prototyping' (RP) and does not know what prices can be asked for this offering. For SCC, RP is a technique used to 3D print molds that can serve as input to the lost wax process. In this way, a casted part can be produced quickly for an acceptable price without investing in an expensive mold. Moreover, RP is a relatively new technology in the market and is used by multiple customer segments and industries, and therefore it is complex to investigate which value relates to RP in practice.

The name 'Special Casting Components Ltd' is a pseudonym for a global steel foundry that is located in three countries. The company is operating in different industrial markets and offers complex steel components to its customers. The customers are mostly operating in international B2B markets. The company has more than 400 employees. Nevertheless, this research is only focused on the location in the Netherlands and the sales, engineering and management unit are mostly used for this research.

Of course, SCC has priced RP, but the pricing is based on costs only, while customer value pricing is preferable because in this way SCC's price is proportional to customer expectation and an optimal price can be determined. SCC wishes to improve their business activities and the objective to contribute in this research is that sales managers will be able to differentiate customers, ask the right questions, and that a value-based sales tool is developed that makes it able to price RP in an optimal way.

1.1.2 Rapid Prototyping research

Time to market and fast development are important in industrial companies. Especially for manufacturers, it is important to be able to rapidly produce customer's products according to changing customer's demands and requirements. Rapid Prototyping (RP) eases this process, because the manufacturer is able to produce faster using 3D printing, and new products can be tested before series production; the 'safe-launch' concept. Moreover, RP saves the customer costs, because the customer can order a smaller amount of products, without paying for the mold-building or having to do minimal product purchase (L. Sun, Hua, Cheng et al., 2020).

Nevertheless, RP technique is a relatively new technology, and it is not investigated yet what the value proposition of RP exactly is and what prices reflect the value of RP. Furthermore, according to SCC, there are a variety of industries that order RP parts for different objectives. So, customer segmentation is necessary to meet the customer needs.

1.1.3 Rapid Prototyping pricing

Besides different customer segments and the fact that RP is a new technology, there are other potential problems that need to be solved to come to a suitable pricing strategy. Firstly, RP can be positioned in the market in different ways. For instance, it can be a way to build a relationship with (potential) customers, because customers can be attached to order series production after the RP process. Or RP can be positioned as a new product-market combination to widen the customer portfolio in the general industry, because smaller product quantities can be offered. Consequently, both market approaches need distinctive pricing strategies. Thus, to come to a suitable pricing approach for RP within SCC, it is necessary to know what kind of industries customers are in, for what objective these customers order RP parts, and which value RP represents for these customers.

Secondly, from pricing literature it is known that value-based pricing (VBP) strategies are the best approach because these are based on the customer's value propositions, so a VBP strategy is preferred (Hinterhuber, 2008). Nevertheless, cost based pricing approaches are most used in these markets, because account managers are often 'price oriented' instead of 'customer oriented'. Furthermore, the 'quantification of value' is often seen as too complex (Töytäri, Keränen, & Rajala, 2017). So it should be investigated how VBP strategies could be implemented and how the sales process must change. Furthermore, because RP is a relatively new technique, it is not known exactly what the value propositions are for RP. In addition, the customer value in use has not yet been investigated. This is important in order to determine the price of RP based on VBP. Finally, other habits in the market, alternative technologies as well as competitors, should also be investigated. Thus, although not exhaustive, this research focuses on value-in-use, alternatives in the market, competition, habits in the market, and the relationship with the 'new technology' to define a VBP strategy for RP within the firm. Moreover, this paper discusses different VBP strategies for distinctive RP customers within SCC.

1.2 Research objective

The aim of this study is to come up with a pricing strategy that is suitable for RP for distinctive customer segments for SCC. Because RP is a relatively new technique that is getting more and more popular in the market. So, it is of importance to investigate what the associated customer value is for RP and what prices can be asked for RP products. Finally, the results of this research may facilitate insights into value-based pricing strategies for distinctive RP customer segments within SCC.

1.3 Research questions

To achieve this, the following research questions are answered: *"What are the value propositions for RP for specific industrial markets?"* And: *"What are the practical implications for implementations of these value propositions and pricing strategies for these segments using VBP?"*

1.3.1 Sub research questions:

1. What is a value-based pricing strategy for business firms?
2. What influences a value-based pricing strategy for business firms?
    a. What is the role of customer value in offering new technologies such as Rapid Prototyping?
    b. What is the role of market forces in offering new technologies such as Rapid Prototyping?
3. What are available frameworks to implement a value-based pricing strategy based on academic literature?
4. What pricing approaches are suitable for SCC based on the formulated theoretical framework?

1.4 Methodology

To answer these research questions, a combination of academic literature and qualitative exploratory research is used, as a case study allows explanatory inductive findings to generalize theories (Baškarada, 2014). Firstly, literature relating to RP and VBP and its associated aspects, such as customer value, are discussed. Secondly, market forces are studied to investigate their influence on VBP strategies. Thirdly, based on selected literature a framework is formed that could be followed to come to a VBP strategy for RP within SCC. Moreover, data of customer value-in-use, habits in the market and the influence of 'new technologies' in the market are the basis of the first step of this framework; customer segmentation. Additionally, SCC's customers are interviewed, in the form of a multiple case study, to get insights into RP's value propositions for distinctive industries, and to get insights in how the customer identification process could be improved. Finally, data of SCC is collected using focus group sessions and a workshop with SCC's sales and management team to get insights in current pricing of RP and to compare whether SCC is responding to customer values in the right way. Consequently, all data and literature are used to implement the formulated VBP framework for SCC's RP.

1.5 Relevance

This study is used to support a manufacturing company in using VBP strategies for RP. Therefore, this research is very case specific and focused on a particular firm. Nevertheless, other manufacturing firms may use this pricing strategy and the used framework to come to a VBP strategy as a base for their own pricing practices. Besides the practical relevance, this research is one of the first that uses RP and VBP theories together to come up with new pricing approaches. To obtain this, for instance, studies of Hinterhuber (2004), Macdonald, Wilson, & Martinez (2008) and Raja et al. (2020), about customer value, VBP, value-in-use, etc. are used. Further, this paper contributes insights into VBP practices within a specific manufacturing company that has introduced a new technology; RP. Finally, this knowledge could be used to further develop pricing practices within this firm based on customer value. In summary, this research:

- Facilitates a customer perspective on RP.
- Identifies the value-in-use and value propositions of SCC's RP, based on habits in the market, alternatives for RP, competitive advantages and the influence of new technologies.
- Uses customer segmentation to identify customer segments based on the conducted value analysis per segment.
- Applied VBP theories to RP.
- Indicates that RP should be introduced as a service rather than as a tool for the production of small product batches.
- Proposes a practical sales tool and process guideline for implementation of the VBP strategy and other implications for SCC's website and quotations structure, for instance.

1.6 Overview

This paper is organized as follows. First, in chapter 2 a brief overview of RP technologies is provided. Second, theories relating to VBP strategies and customer value are discussed. Third, factors that may influence VBP strategies such as; habits in industrial markets, influences of new technologies and servitization are elaborated. Fourth, a theoretical framework is provided to develop and implement a VBP strategy for SCC's RP. In chapter 3 the research design and data collection methods of this research are discussed. Followed by the results of this research in chapter 4. Finally, the discussion section of this paper is provided in chapter 5.

Chapter 2: Theory

In this chapter, relevant academic literature is discussed relating to available pricing strategies for Rapid Prototyping (RP). Firstly, RP technologies are discussed, followed by value-based pricing strategies and its associated components. Further, the importance of the customer's perspective is emphasized and therefore value-in-use and value propositions are elaborated. Further, techniques are discussed to quantify this customer's value. Thirdly, relevant habits in industrial markets are discussed to get a view of the influence of market forces to pricing strategies. Fourthly, the influence and implementation of new technologies are discussed to get insights into the impact the new technology (RP) may have on pricing strategies. Finally, a framework is composed to ultimately build an appropriate pricing strategy for RP's distinctive customer segments.

2.1 An overview of Rapid Prototyping

In the casting process, building a wax injection mold is very money- and time consuming and therefore not to the benefit of the customers. In particular when the customer is still in the test phase with the products that will be ordered for series production at the manufacturer. In these situations RP can be a beneficial solution.

As mentioned in the study of Kriesi, Bjelland, & Steinert (2018), RP is a tool that helps "to rapidly improve the design during the product development process" (p. 206). Further, the study of Kriesi et al. (2018) describe that RP facilitates the evaluation of the 'four Fs' (form, fit, function and feasibility) of 'new designs', and makes it possible that a small amount of parts can be produced to test the design in the end-products or on customers to see how it interacts. In this way, designs can be improved based on customer interactions, and designs can be finalized to the exact requirements (Kriesi et al., 2018). As a consequence, parts built from RP that are ready for series production will reduce material costs, realize more sustainable (mass) production, and create higher quality levels, because it meets the exact requirements (Kriesi et al., 2018).

In RP, 3D printing can be used to fabricate parts. According to Rayna & Striukova (2016), 3D printing is a relatively affordable tool that businesses started to integrate within their business models for product development. Moreover, "3D printing is a form of 'additive' manufacturing, where a three-dimensional object is 'printed' (built) by adding layer after layer of a particular material" (Rayna & Striukova, 2016, p. 215).

Finally, when RP is successfully integrated in an organization the term 'rapid tooling' can also be used. Moreover, rapid tooling is often used to test custom-engineered prototypes in niche markets (Rayna & Striukova, 2016). Furthermore, Rayna & Striukova (2016) mention that RP can be used to create an adaptable business model, to add a particular market to the customer base, for instance. This development makes it possible to offer solutions for different customer needs, such as a custom-engineered product in a small quantity.

So with RP, companies can already use, test and optimize their parts/designs, they do not have to wait till the mold is build, the products are more sustainable, affordable to build and will probably exceed customer's needs (Kriesi et al., 2018; Rayna & Striukova, 2016; L. Sun et al., 2020). All these components together affect the value proposition of RP.

2.2 Value-based pricing strategies

In this section value-based pricing (VBP) strategies for business-to-business firms are discussed. Additionally, constructs of VBP strategies are discussed, such as; the role of customer value, value-in-use, but also methods to quantify the customer value.

A lot of managers see 'pricing' as a zero-sum game and as a consequence do not spend a lot of attention towards pricing strategies. Moreover, Hinterhuber (2004) states: "what is gained by the firm is lost by the customer and vice versa" (p. 766). Secondly, managers think that prices are determined by the market and not by themselves (Hinterhuber, 2004). Thirdly, there are a lot of 'myths' according to 'pricing'. For instance, it is assumed that high prices cannot go together with market leadership or high market share (Hinterhuber, 2004). However, pricing strategies do have a significant influence on the profitability of a company and therefore need investigation (Hinterhuber, 2004).

In general, pricing strategies can be divided into three groups: cost-based pricing, competition-based pricing and value-based pricing (VBP) (Ceylana, Koseb, & Aydin, 2014; Hinterhuber, 2008). According to Hinterhuber (2008), VBP is the superior pricing strategy, because this approach is based on the customer value proposition. However, this approach is the most difficult to investigate. Further, the second best pricing approach is competition-based pricing because the competition's price is taken into account, and data is easily obtained. Lastly, the weakest approach is cost-based pricing because the competition and the customer's willingness to pay are not taken into account. Nevertheless, in cost-based pricing, data is easily obtained (Hinterhuber, 2008).

So, to determine a profitable price it is all about 'customer value', and not just about cost accounting (cost-based pricing) or competitor's prices (competition-based pricing) (Hinterhuber, 2008). Consequently, when high prices reflect a high customer value then it is possible to achieve a high market share (Hinterhuber, 2004).

2.2.1 Value propositions

To obtain an optimal value proposition, we should firstly identify what a value proposition is and discuss the different types of value propositions. Value propositions are about understanding the customer's needs. Moreover, Coppenhaver (2018) defines a value proposition as: "a specific promise to a targeted segment or customer of the unique value we offer at a specific price" (p. 204). Nevertheless, a lot of companies assume that all beneficial product features are also customer benefits, while this is actually not the case. Essentially, Hinterhuber & Snelgrove (2017) emphasize the importance of a problem solving mindset where account managers focus on solving problems and saving money, instead of focusing on product costs and features.

According to Anderson, Narus, & Rossum (2006), there are three types of value propositions (Table 1). Firstly, an 'all benefits' value proposition means that the company simply mentions all the benefits of the product to the customer. However, in this way it will not become clear what the actual differences are compared to similar products. Further, the second type of value proposition; 'favorable points of difference' can be assumed as a better value proposition, and answers the question: "Why should our firm purchase your offering instead of your competitor's?" (Anderson et al., 2006, p. 94). Finally, Anderson et al. (2006) mention the 'resonating focus' as the best value proposition. The 'resonating focus' value proposition is about emphasizing the superiority of product aspects that are most important to the target customers (Anderson et al., 2006). Moreover, this last value proposition focuses most on creating customer value.

Table 1 Three types of value propositions (Anderson et al., 2006)

Value Proposition	All Benefits	Favorable points of difference	Resonating Focus
Consists of:	All benefits customers receive from a market offering	All favorable points of difference a market offering has relative to the next best alternative	The one or two points of difference (and, perhaps, a point of parity) whose improvement will deliver the greatest value to the customer for the foreseeable future
Answers the customer question:	"Why should our firm purchase your offering?"	"Why should our firm purchase your offering instead of your competitor's?"	"What is *most* worthwhile for our firm to keep in mind about your offering?"
Requires:	Knowledge of own market offering	Knowledge of own market offering and next best alternative	Knowledge of how own market offering delivers superior value to customers, compared with next best alternative
Has the potential pitfall:	Benefit assertion	Value presumption	Requires customer value research

2.2.2 Customer value

Customer value can be defined in several ways. According to the study of Hinterhuber (2004), a customer's economic value can be defined as "the difference between the consumer's willingness to pay and the actual price paid" (p. 769). Nevertheless, in this definition the customer value will change if the price changes. So, a better definition for customer value will be: the 'reference value' (price of best alternative) plus the value that differentiates the offering from that of the alternative product (Hinterhuber, 2004).

Besides economic perspectives, Hinterhuber & Snelgrove (2017) discusses customer value and its five 'basic premises': 'customer insight', 'collaboration', 'measurement of business impact', 'differentiation' and 'substantiation'. 'Customer insight' means that the value is always defined by the customer, and not by the company itself. Secondly, 'collaboration' signifies that value is in the first place created in collaboration with customers and that they must recognize the value delivered. Thirdly, 'measurement of business impact' means that value is quantified in monetary benefits. Fourthly, 'differentiation' means that the value of the offered product is compared to its reference product. Finally, 'substantiation' means that: "value is always substantiated by case studies and by documented performance improvements" (Hinterhuber & Snelgrove, 2017, p. 65).

2.2.3 Perceived value and quality

For business firms, quality is an important contributor to the assessment of customer value and satisfaction, and a forecast for future customer behaviour (Macdonald et al., 2008). Moreover, "from a provider perspective, perceived quality is an important performance measure for management control and decision-making including the pricing decision" (Macdonald et al., 2008, p. 6). Essentially, in perceived quality it is important to know which activities lead to customer satisfaction.

To measure the perceived quality, the framework of Macdonald et al. (2008) is used (Figure 1), because this model not only reflects the customer processes but also connects the product, service, relationship and network quality and thus provides a more complete picture of how a company can assess and improve its customer value-in-use and which processes have an influence on this. The outcomes of the model of Macdonald et al. (2008) can form the base for the customer value propositions. Finally, Macdonald et al. (2008) mention that service providers should firstly focus on the utilitarian goals, and when these are fulfilled, the hedonic benefits become important.

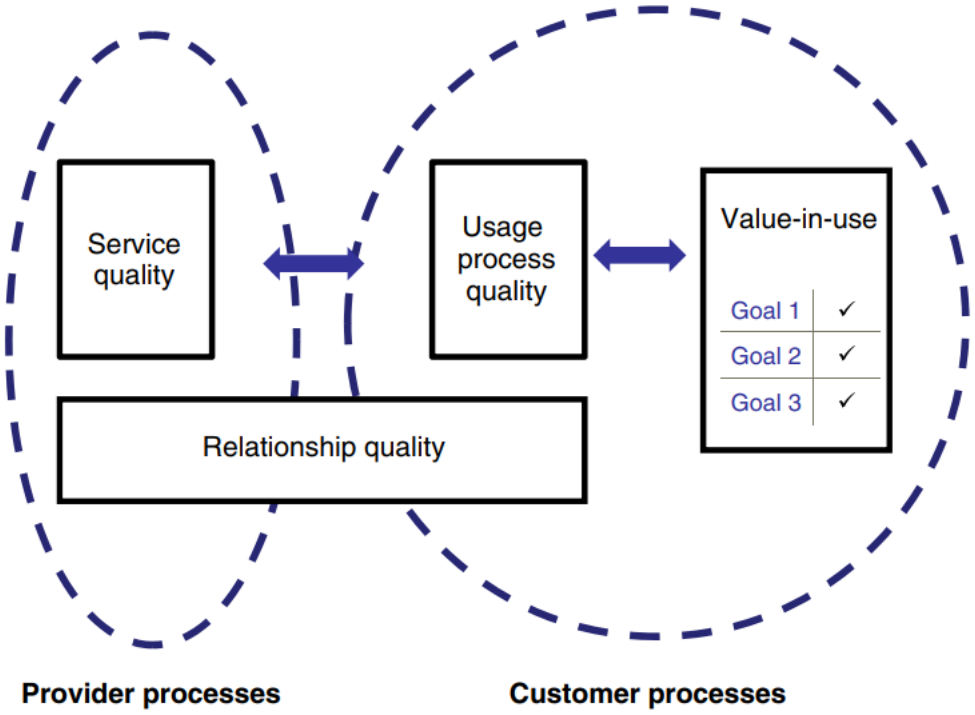


Figure 1 "Conceptual framework for customer assessment of value-in-use" (Macdonald et al., 2008, p. 673)

2.2.4 Voice of Customer

Voice of Customer (VOC) is a methodology providing tools and analysis techniques to identify the customer value, or value-in-use. According to Gaskin, Griffin, Hauser, et al. (1993) VOC is:

- A complete set of customer wants and needs;
- Expressed in the customers own language;
- Organized the way the customer thinks about, uses, and interacts with the product or service;
- Prioritized by the customer in terms of both importance and performance.

Furthermore, Griffin, & Hauser (1993) describe VOC as: "a hierarchical set of 'customer needs' where each need (or set of needs) has assigned to it a priority which indicates its importance to the customer" (p. 2). As a method and process, VOC consists of four steps: "1) identifying customer needs; 2) organizing customer needs; 3) measuring or estimating the relative importance of the needs so that they can be prioritized, and; 4) applying the results with the goal of customer satisfaction" (Freeman & Radziwill, 2018, p. 4).

To identify the specific customer needs for a certain product, 'VOC interviews' can be used (Gaskin et al., 1993). The hierarchical structure of these needs consists of 'primary needs' and forms the basis of the strategic direction of marketing (Gaskin et al., 1993). These 'primary needs' are elaborated into 'secondary needs', and these will give the firm information about what they should do to satisfy the corresponding 'primary need' (Gaskin et al., 1993; Griffin & Hauser, 1993). Finally, the 'tertiary needs' are the actual 'operational needs' and form the basis for R&D to design product characteristics or an advertisement (Gaskin et al., 1993; Griffin & Hauser, 1993).

Finally, priorities and customer perceptions of performance can be assessed using quantitative research in the form of surveys, for instance. All steps together can be used for insights into customer's value-in-use.

2.2.5 Quantification of value

According to Hinterhuber & Snelgrove (2017), the process of value quantification starts with insight into customer needs. Additionally, listening to the customers is important in this first step. In the next step, the 'economic customer value' quantification starts. Hinterhuber has outlined a procedure to quantify this economic customer value. Firstly, it should be investigated what customers view as the best 'reference product'. Secondly, the market should be segmented. This means that it should be investigated how customers value and use their reference products. Moreover, field research is necessary into customer behaviour to be able to implement VBP (Hinterhuber, 2004). Thirdly, it should be investigated how the home-product differentiates from the reference product. Further, the competitive advantages should be investigated. To do this, VOC research again can be used to assess factors such as: "reliability, performance, ease of use, longevity, life cycle costs, user and environmental safety, service (in terms of delivery reliability, delivery speed, and flexibility of deliveries), superior esthetics, prestige, and so on" (Hinterhuber, 2004, p. 770). Fourthly, the customer value of these 'competitive advantages' should be determined. To measure customer value, conjoint analysis can be used, for instance (Hinterhuber, 2004, 2008). Fifthly, the reference value and the differentiation value should be summed to get the total economic value, also known as the 'value pool' (Hinterhuber, 2004). Finally, the 'value pool' can be used "to estimate future sales at specific price points" (Hinterhuber, 2004, p. 770).

Further, Hinterhuber (2004) presents a framework for willingness to buy for effective VBP strategies. This framework is shown in Figure 2 below and consists of the economic value in relation to the price and the perceived fairness of the transaction. Additionally, Hinterhuber (2008) mentions that it is important to be able to ask a price premium when VBP is interpreted within an organization. This means that account managers should be rewarded based on profitability or quality of projects, rather than market share or sold quantities (Hinterhuber, 2008). Finally, a sales manager should focus on selling 'solutions' instead of products and should listen carefully to the customer's wishes (Hinterhuber, 2008).

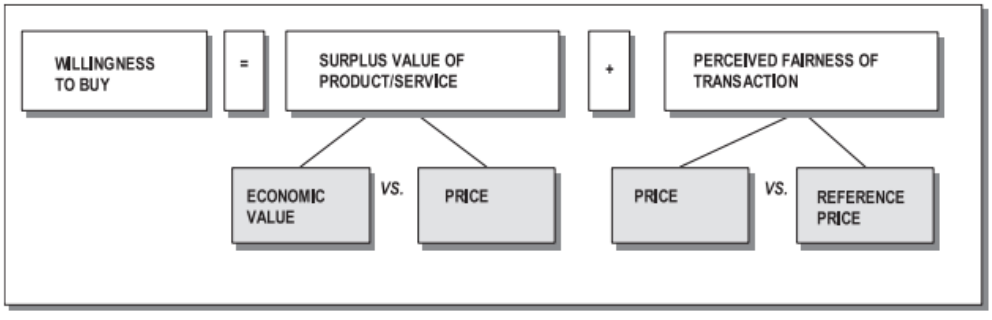


Figure 2 Framework of 'willingness to buy' (Hinterhuber, 2004)

2.2.6 Total Costs of Ownership

Total costs of ownership (TCO) is also an important factor to assess customer value. As mentioned in Snelgrove (2012), customers rank TCO as more important than price. In addition, Hinterhuber, Snelgrove, & Stensson (2021) have made a model with 'the new rules of purchasing in B2B' (Appendix 1) where purchase criteria are based on 'value first' and therefore the importance of total cost and total value of ownership and performance-based contracts are emphasized. Furthermore, when TCO is emphasized, purchased products can be seen as 'investments' to obtain monetary benefits (Hinterhuber et al., 2021). Thus, it may be that the initial price for the product is higher, but in the end the customer will value a product higher if the TCO are lower than that of the reference product, for instance.

Furthermore, TCO covers all phases of the life cycle: acquisition, operation and disposal, and takes all these costs into account (Gray, Helper, & Osborn, 2020; Snelgrove, 2012). Based on TCO calculations, 'pay for performance' contracts are possible, and it can be investigated if the realized value is more than the TCO (Snelgrove, 2012). Moreover, in the case study of Raja, Frandsen, Kowalkowski et al. (2020) a tool for calculating TCO is used for value-based pricing strategies to measure the quantity of the customer value.

2.3 Factors that influence value-based pricing strategies

This section discusses other factors that could influence VBP strategies and focuses on market forces and competition, and the influence of new technologies on pricing strategies.

2.3.1 Habits in industrial markets

According to Töytäri et al.(2017), VBP is not much used in industrial markets. Moreover, their case study research revealed that employees thought that a change of mindset and serious re-training is required to implement VBP within organizations, because normally they focus on technological product attributes in their sales process. So, in industrial organizations a lot of account managers are mostly 'product oriented' and less focused on 'what they potentially can offer customers'. Consequently, customer segmentation is less important (Töytäri et al., 2017). Additionally, customer value quantification is often too complex because it is difficult to access customer data and customers do not share much of their challenges or specific needs in early stages of the sales process (Töytäri et al., 2017).

Nevertheless, the most important reason for industrial companies to use a cost-based or competition-based pricing approach is that industrial buyers simply set their requirements and list the most qualifying vendors and ultimately choose the one with the lowest price or fastest payback time (Töytäri et al., 2017).

According to Monaghan & Tippmann (2018), industry recipes are the reason why manufacturing companies in a particular industry start to share similar perspectives. Because "industry recipes are defined as a set of heuristics shared within an industry" (Monaghan & Tippmann, 2018, p. 474). They are referred to as things that everyone in the industry understands. So, in the manufacturing industry there are shared pricing approaches that almost every company uses for its pricing practices, well known as cost-based pricing.

To assess these 'habits' in the manufacturing industry that might influence the pricing strategy in more depth, the competitor's pricing approach is investigated. Therefore, an online review is conducted that investigates the offered prices and services on the competitor's websites. The results on this online review can be found in the results section.

To conclude, in the manufacturing industry cost-based pricing is the norm. This is an interesting outcome, because differentiation to a more customer-centric approach is possible. To achieve this, it is important to know the exact customer needs to be able to stand out from the other vendors and to create long-term value. Furthermore, according to Töytäri et al. (2017): "You need to know your customer better than the customer knows itself" (p. 242). Finally, these customer values can then serve as input for a VBP approach.

2.3.2 New technologies in industrial markets

In this section the influence of new technology is discussed. As mentioned by Christensen (1997), technology is defined as: "the processes by which an organization transforms labor, capital, materials, and information into products and services of greater value" (p. 13). Further, Christensen (1997) discusses the 'innovator's dilemma' in his book and distinguishes between 'sustaining technologies' and 'disruptive technologies'. Moreover, 'sustaining technologies' relate to established products and improve their performance, while 'disruptive technologies' often create new customers and new customer value (Christensen, 1997). As a consequence, disruptive technologies lead more often to a firm's failure (Christensen, 1997).

Secondly, Christensen (1997) discusses 'market needs versus technology improvements', because this can also be a source of firm failure. As an example, Christensen (1997) mentions the developments in the computer industry. Because technological improvements of computers have increased more rapidly than the customer's needs. This means that manufacturers provide more than the customer needs and therefore the customer is not willing to pay for these new technological improvements. In addition, this example mentions the importance of the need of an equilibrium between customer needs and the offered products (Christensen, 1997).

Thirdly, Christensen (1997) discusses 'disruptive technologies versus rational investments' as the last aspect of his 'failure framework'. This last element emphasizes that the firm's most profitable customers initially do not use or want products made of disruptive technology. So, listening to the most important customers of the firm will often not lead to inventing products based on disruptive technologies (Christensen, 1997).

When relating Christensen's (1997) theoretical framework to RP, RP's technology can be defined as a 'sustaining technology', because RP improves the performance of the series production (established product), and is not 'smaller', 'simpler' or, 'more convenient to use', which are all aspects of disruptive technologies (Christensen, 1997). Nevertheless, it is not investigated yet if customer values differentiate much between RP and series production. Thus, for the second aspect of Christensen's (1997) 'failure framework', investigation of the customer needs is necessary to define if RP reflects the customer needs and to know if customers are willing to pay for the additional value that RP delivers.

2.3.3 Servitization

The importance of services in business-to-business manufacturers becomes more and more important. According to Raddats, Kowalkowski, Benedettini, et al. (2019), the integration between products and services is well known as 'servitization'. By using servitization, additional customer value can be created by adding services to the manufacturers' core business (Raddats et al., 2019). Furthermore, servitization could be used as a way to protect the manufacturer's core business. Moreover, for a large manufacturer a service strategy could be used as product differentiation, to create competitive value (Raddats et al., 2019). Finally, the created customer value can be used in the VBP approach.

According to Raddats et al. (2019), services can be described in two ways; services supporting the supplier's product (SSPs) and services supporting the customer's actions (SSCs). After sales and product maintenance services are referred to as SSPs, while R&D services are identified as SSCs. Furthermore, "SSCs directly affect revenue and profit streams" (Raddats et al., 2019, p. 212).

Other interesting concepts that are mentioned in the study of Raddats et al. (2019) are 'system selling', 'hybrid offerings' or 'Product-Service Systems (PSS)'. These concepts are defined to solve specific customer problems and are services composed of combinations of products and services together. Additionally, these concepts are referred to as 'solutions' (Raddats et al., 2019). Finally, there are 'result-oriented PSS', which are pay-for-performance structures, or structures for which customers only pay for value-in-use (Raddats et al., 2019).

However, to implement servitization within a firm, commitment is important. According to Sjödin, Parida, & Kohtamäki (2019) "manufacturers must complement service innovations by either relational or formal contractual arrangements with customers to protect their innovations and capture value" (p. 908). Another way to get customer commitment is by increasing the 'perceived switching costs'. These are costs a customer needs to make when switching to another supplier. Moreover, the more unique the provider's resources and capabilities are and the more time it will take to get similar results by another supplier, the higher the switching costs are (Sjödin et al., 2019). Further, the attractiveness of alternatives and explicit contacts play a role in gaining customer commitment and loyalty (Sjödin et al., 2019).

2.4 Framework to define VBP for RP

As mentioned before, value-based pricing (VBP) is based on understanding the customer value, and does focus less on product or service features. Furthermore, VBP moves away from a 'one-size-fits-all pricing policy', because different pricing strategies are necessary to respond to distinctive value propositions (Hinterhuber & Liozu, 2014). According to Raja et al. (2020) the purpose of VBP is to increase customer's willingness to pay, because prices are based on the customer value. Moreover, to obtain insights into customer value, it is necessary to have insights into customers behaviour, such as: purchase histories and the value being delivered (Raja et al., 2020). Additionally, to segment the customers in an efficient way, value-in-use, habits in the market and the influence of new technologies need to be assessed.

Furthermore, to formulate and implement a VBP pricing strategy for RP, a framework is composed based on the theories discussed (Figure 3). The capabilities of VBP of the study of Raja et al. (2020) are used (Appendix 2) together with the steps mentioned in Raja et al. (2020); customer identification and analysis, implementation of value-based pricing and value-based selling, verification of value and learning (Appendix 3). As this framework follows an appropriate path that ultimately results in a pricing strategy.

The process starts with 'Customer Segmentation'. In this step the customers are identified based on three constructs: Alternative techniques that can be used for RP, habits in the market, and the purchase intentions for RP. Secondly, customer value is identified based on the customer's input. For this, the framework of Hinterhuber (2004) (section 2.2.5) and the model of Macdonald et al. (2008) (Figure 1) are used. Based on the customer's input, the alternative techniques for RP appear and sales tools can be formulated for the implementation of VBP. The 'Customer Identification and Analysis' process ends with the definition of the value proposition for the distinctive identified customer segments.

The implementation of VBP and VBS starts with ‘Fostering trust and building reputation’. This step describes how SCC should position itself in the market and what resources can be used to contribute to this. Secondly, the value communication is discussed based on the perceived value-in-use for the distinctive customer segments.

Finally, the ‘Verification of Value’ process quantifies, monetizes and assesses the value created for the different customer segments. To do this, Willingness to Pay (WTP) and Key Performance Indicators (KPIs) are used to measure and express the value RP represents to a specific customer in terms of money or savings over the next best alternative. Based on this information, different pricing strategies can be developed for distinctive customer segments. Lastly, the strategies will be implemented and assessed within SCC and improvements will ultimately follow. Based on SCC’s input the strategies will improve based on ‘knowledge management’.

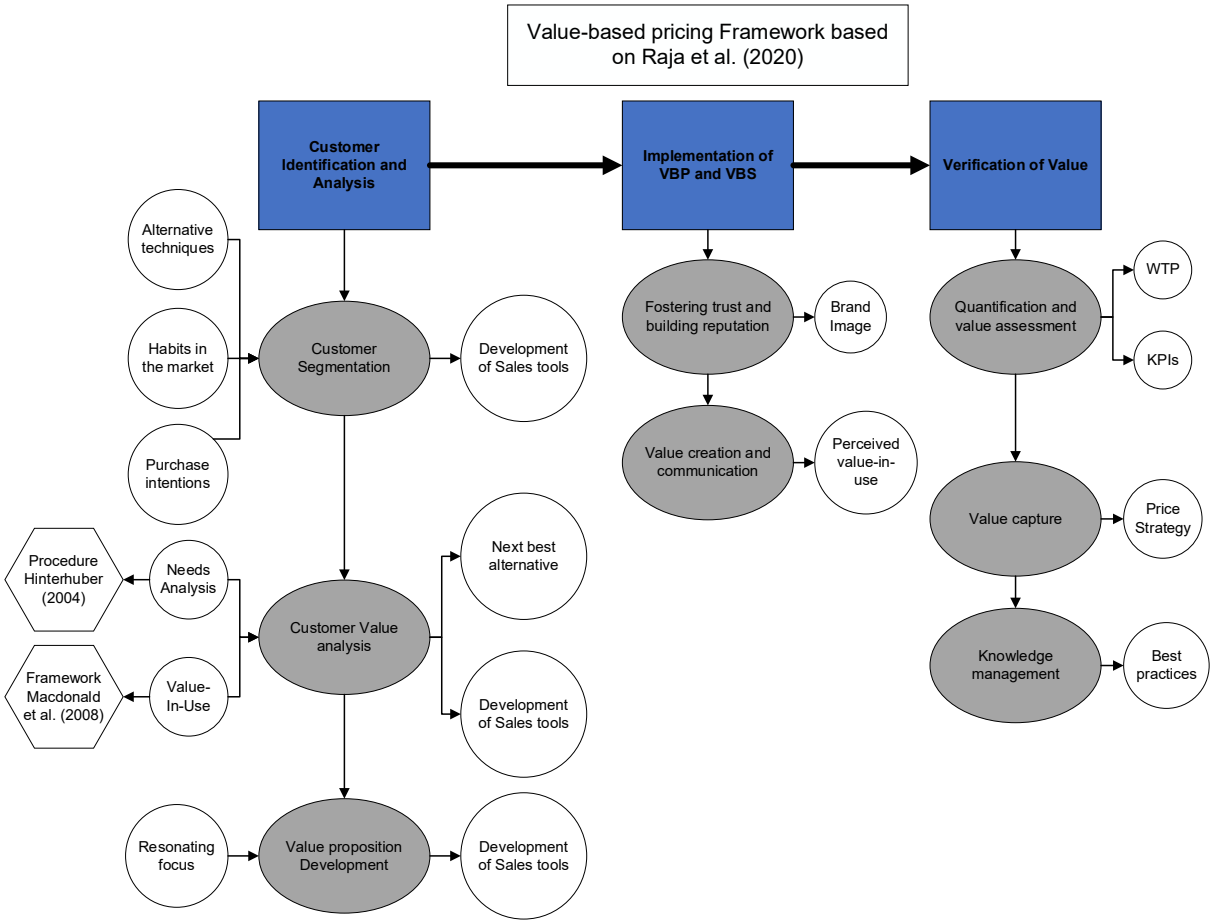


Figure 3 Framework to define VBP for RP

2.5 Conclusion

Knowledge of VBP strategies for business firms is of importance to improve pricing for RP. VBP is based on the customer's value propositions that relates to the perceived value of RP's products. To measure this customer value, Hinterhuber (2004) has outlined a value quantification process. Further, the influences of new technologies are discussed. RP has been identified as an 'sustained technology' which means that there are less risks compared to 'disruptive technologies'. Nevertheless, it should be investigated if the value of RP represents the customer needs. Because an equilibrium between these two aspects is important to know if customers are willing to pay for the additional value of RP products. Moreover, the habits in industrial markets are discussed. VBP is rarely used in these markets, because pricing is mostly based on costs or competitor's prices. Therefore, there is no clear guideline to identify the customer needs. So, for business firms it is crucial to know customers almost better than they know themselves. To investigate the habits in the industrial market better, in the results section an online review is used to identify pricing strategies used by SCC's competitors, or other companies that produce RP products.

Besides theories, a framework is composed that ultimately leads to distinctive pricing strategies for RP. In this framework the importance of the customer identification process is emphasized, because in a VBP strategy the identification of customer values is most important. The framework continues with the implementation of VBP and the verification of value. This last step is crucial to quantify or to monetize the value of RP for distinctive customer segments. This quantification of value can be done using TCO or ROI, but can also be based on the created savings of RP in comparison with the best alternative for customers. In this way, the requested price for RP products will be seen as an investment for future benefits or cost savings.

Finally, the most important theoretical contributions are summed up:

- RP is a new value-adding technology for castings.
- VBP is the preferred pricing strategy.
- For VBP, the understanding of customer needs, customer value and value-in-use is required.
- A value proposition needs to be based on customer input that can be obtained by VOC research.
- Pricing in business-to-business firms is mostly based on costs or competitors, therefore creating a VBP strategy for RP is a challenge for SCC.
- A framework is composed to implement a VBP strategy for SCC's RP based on theory and is followed in the research into customer value, the development of SCC's propositions for RP, the value creation and communication of RP, and the quantification and the value assessment of RP.

Chapter 3: Research design

3.1 Case study

This research is carried out on behalf of a steel foundry in the Netherlands (SCC) that offers RP to its customers. SCC offers RP to its customers to meet different customer needs. Moreover, customer segmentation is possible within SCC to investigate which pricing strategies are appropriate for these distinctive segments. SCC is a suitable company for investigation, because it is a global player that has customers in various industries, which helps to improve the applicability of this research. Furthermore, SCC can be described as both a 'critical case', because SCC's RP pricing is of strategic importance to the general RP pricing problem, and as 'paradigmatic case' because SCC is used to test the new formulated pricing strategy (a prototypical case) (Baškarada, 2014).

This research is written to advise one particular manufacturing company with its RP pricing strategy. To investigate this, different customers from distinctive industries of SCC are investigated. This research can therefore be characterized as a qualitative 'exploratory' multiple case study (Baškarada, 2014). Moreover, a case study is a data collection method that is used to collect primary qualitative data from groups or individuals. Furthermore, according to Ridder (2017), a case study can be used to test, develop or extend the theory by studying a certain unit of analysis in a distinct setting and is often based on a non-random sample because it is about the chosen case that is of interest. Additionally, Baškarada (2014) mentions that a case study can be used as a tool for organization learning and evaluation, and therefore can be used to evaluate the current pricing strategy of RP in this research in a specific business context. Thus, as Baškarada (2014) states: "While case studies do not aim to generalise populations (statistical generalization), similar to experiments, they aim to generalise to theories (analytical generalization)" (p. 4). So, this study is used to assess RP's current pricing and to test a pricing framework formed by academic literature in practice.

3.2 Multiple methods

For this research, a qualitative exploratory research is conducted, based on desk and field research, that aims towards analytical generalization (Baškarada, 2014). For this, a variety of methods are used to gain an understanding of relevant underlying customer values and motivations, market habits and practices and internal drivers within SCC. If used in parallel, insights can be obtained as well as solutions and ideas be developed for implementation.

To answer the sub-research questions (1-4) as mentioned in section 1.3.1, the following research methods are used:

1. Desk research is conducted in the form of a literature review that elaborates knowledge and theories about VBP approaches, customer value, habits in industrial markets and influences of new technologies.
2. An online review is used to understand habits in the market and other market forces that could influence pricing strategies (Field research).

Thereafter, the main research questions could be answered. Firstly, to find out what the value propositions are for RP based on VBP for specific industrial markets, the following research methods are used:

3. Interviews are conducted for information about SCC's customers about experiences with RP technology, its benefits, underlying customer values, experiences with SCC and current pricing approaches in the industry.
4. Internal information from SCC is obtained using a workshop and group discussions with sales and management.

Secondly, to state practical implications for implementations of these value propositions and pricing strategies for these segments, the following research method is used:

5. Focus groups with SCC's sales team are used for data about how the value propositions and pricing strategies could be implemented within SCC.

3.3 Data collection methods

As mentioned before, data collection took place in five different ways. Each method is discussed in detail below.

3.3.1 Literature review

The literature review is used for desk research. To find academic literature, advised books and research papers from the supervisors are used. Further, ScienceDirect and Google Scholar are used to find appropriate research papers and literature.

3.3.2 Online review

Secondly, the online review is used for information of SCC's competitor's pricing approaches and to understand habits in the market and other market forces that could influence pricing strategies. Moreover, web pages are investigated to achieve knowledge of pricing habits used in industrial markets relating to RP. The data collection is executed using information of SCC's sales team on (possible) RP competitors, mentioned company names of interviewees, and a search from Google (Table 2). Thus, the online review is mostly based on snowball sampling.

Table 2 Online Review Search Terms

Online Review Search Terms			
1.	Rapid Prototyping	9.	Rapid Prototyping investment casting
2.	Rapid Prototyping steel	10.	Additive manufacturing
3.	Rapid Prototyping steel pricing	11.	Additive manufacturing steel
4.	Rapid Prototyping pricing	12.	Additive manufacturing pricing
5.	Rapid Prototyping casting	13.	Additive manufacturing steel pricing
6.	Rapid Prototyping precision casting	14.	Additive manufacturing Rapid Prototyping
7.	Rapid Prototyping parts	15.	Steel foundry Rapid Prototyping
8.	Rapid Prototyping parts pricing	16.	Steel foundry Rapid Prototyping pricing

3.3.3 Customer interviews

Thirdly, the interviews with SCC's customers are all semi-structured and are based on a standardized protocol with predefined (open-ended) questions. This protocol is shown in Table 3, and the complete protocol can be found in Appendix 4. The interview questions are designed based on criteria from the theory chapter. Most interviews lasted around 30 minutes, with some over 40 minutes as shown in Table 4. To gather data from these interviews, the interviews are recorded, transcribed and coded. Further, the interviewee selection is based on snowball sampling. To improve trustworthiness, the respondents are informed that the interviews are recorded and that notes are taken. Additionally, the respondents need to approve the transcription. Based on these interviews, customer's pricing assessment criteria (KPIs) can be defined.

Table 3 Interview Protocol

Interview Protocol
1. Introduction of Maxime Kooistra and research goal
2. Interviewee background and relationship to SCC
3. Questions relating to SCC's Rapid Prototyping service/products
4. Questions relating to SCC's account management
5. Questions relating to SCC's Rapid Prototyping pricing
6. Wrap-up: Summarize findings to get additional input
7. Review if there is anything else the interviewee wishes to add

Table 4 Overview of sampled interviews and data collection

Interviewee	Duration (min)	Segment	Function informant	Company location
1.	35	Engineering company	Engineer	Belgium
2.	30	Security systems manufacturer	Project manager	Germany
3.	22	Carrier systems manufacturer	Engineer	Germany
4.	21	Process technology manufacturer	Junior Engineer	The Netherlands
5.	51	Nautical equipment manufacturer	Buyer	The Netherlands
6.	41	Mechanical engineering	Buyer	Germany
7.	15	Painting manufacturer	Product Designer	The Netherlands
8.	40	Oil drilling	Mechanical Engineer	United States of America
9.	30	Design agency	Product Designer	The Netherlands
10.	35	Wheelchairs manufacturer	Product Designer	The Netherlands
11.	38	Automotive manufacturer	Component Designer	France

Additionally, the interviews with SCC's customers are used to assess SCC's current pricing approach and relationships with account managers. This information is necessary to identify how the sales process could be improved and which information is necessary to implement optimal pricing. Nevertheless, this information is very case specific and therefore not generalizable.

3.3.4 Group discussion & focus groups

Fourthly, a group discussion is used to assess the knowledge of SCC's account managers and other managers about VBP. Further, this group discussion is used to inform SCC's employees better about the research objective, their involvement, and the expected practical outcomes, which is important in case study research according to Baškarada (2014). Moreover, this method is used in combination with a workshop about VBP facilitated by an external expert[1], because account managers are stimulated to think more 'outside the box' when they are familiar with this pricing approach and can form an external perspective. According to Baškarada (2014), eight to twelve participants are sufficient for a group discussion. That is why the group discussion within SCC is elaborated with eight participants. To gather data from these research methods, the workshop and group discussion are recorded and notes are taken during the workshop and group discussion.

Finally, two focus groups are held to develop implications for implementation of the VBP pricing approach based on the segment specific value propositions. The first focus group is held after the interview data is gathered and some results are identified in the research. In this focus group interim results are discussed with SCC's sales team to brainstorm about ideas for implementation of VBP. The second focus group discussion took place after the segment specific value propositions were defined. In this second focus group discussion the final implementation ideas of SCC's sales team are discussed. Lastly, the data from both focus groups is reported, analyzed and processed in the thesis results section.

3.4 Trustworthiness

While in a quantitative research the terms 'reliability' and 'validity' are used, in a qualitative research the term 'trustworthiness' is used. To assess the trustworthiness of this qualitative research, Guba's Model is used in which the consistency, neutrality, truth value and applicability are assessed (Yulianto & Krefting, 1991). Table 5 below provides an overview of Guba's criteria compared to quantitative approaches.

Table 5 Qualitative vs. quantitative research approaches (Yulianto & Krefting, 1991)

Comparison of qualitative and quantitative research approaches		
Criterion	*Qualitative Approach*	*Quantitative Approach*
Truth value	Credibility	Internal validity
Applicability	Transferability	External Validity
Consistency	Dependability	Reliability
Neutrality	Confirmability	Objectivity

[1] External expert was Maarten Wijnheijmer, who is an external supervisor in this research who has experience in coaching, guiding and implementing value-based pricing within international companies.

In addition, Yulianto & Krefting (1991) have summarized suitable strategies for each qualitative approach that can be used to determine reliability. These strategies are listed in Table 6.

Table 6 Strategies to establish trustworthiness in qualitative research

Strategies to establish trustworthiness (Yulianto & Krefting, 1991)	
Strategy	*Criteria*
Credibility	Prolonged and varied field experience
	Time sampling
	Reflexivity (field journal)
	Triangulation
	Member checking
	Peer examination
	Interview technique
	Establishing authority of researcher
	Structural coherence
	Referential adequacy
Transferability	Nominated sample
	Comparison of sample to demographic data
	Time sample
	Dense description
Dependability	Dependability audit
	Dense description of research methods
	Stepwise replication
	Triangulation
	Peer examination
	Code-recode procedure
Confirmability	Confirmability audit
	Triangulation
	Reflexivity

In this section the trustworthiness of this study is analysed using the predefined criteria of Lincoln and Guba (1985); consistency, neutrality, truth value and applicability.

3.4.1 Consistency & neutrality

According to Yulianto & Krefting (1991), the consistency of a study is also referred to as ‘stability’, meaning that the study findings are consistent or stable when the research is replicated. Second, neutrality indicates that the study is free of bias, this refers to ‘auditability’ which suggests that similar solutions and results should be obtained when the research is conducted by another researcher. Moreover, to increase consistency and neutrality of a research, a replication technique can be built, or an auditor or supervisor can be included from the start of a research (Yulianto & Krefting, 1991).

To make this research repeatable, a case study protocol is made to standardize this research (Table 7) (Baškarada, 2014). The whole protocol with the approaches used for the interviews, workshop and group discussion can be found in Appendix 5.

Table 7 Case Study Protocol (Baškarada, 2014)

Case Study Protocol
1. Introduction to the case study
2. Purpose of the protocol
3. Data collection procedures
4. Outline of the case study report
5. High-level case study questions
6. References

Further, since the start of this thesis, an external supervisor/expert[2] has been appointed who contributes ideas to the research process, takes a critical look at the methods used and gives advice where necessary. Moreover, this research uses triangulation; theories are used as an analytical lens and external experts are used to arrive at empirical insights.

Online review

The online review may be subject to lower consistency because only Google is used as a search engine machine and websites that appear on top of the screen could differentiate between users, because Google uses an algorithm that adapts to the habits of the user. In addition, the search terms can be expanded even further, which influences the results of the online review.

Interviews

The interviews with SCC's customers may be subject to lower consistency and neutrality, because:

- An interview is not "a neutral tool to evoke rational responses and uncover truths, but rather a situated event in which the interviewer creates the reality of the interview situation" (Qu & Dumay, 2011, p. 247).
- The respondents are customers of SCC who probably not share all information with the interviewer due to commercial consideration.
- The interview results do not represent SCC's entire customer portfolio, since the interview sample was created by snowball sampling and may therefore distort the value of RP. In addition, there is a greater chance that 'satisfied customers' are more likely to want to participate in the interview than 'dissatisfied customers'. As a result, 'satisfied customers' can be overrepresented in the interviews, which means that important results can be missing.
- Only 11 interviews were conducted, so there is a chance that not every customer segment is represented in the sample.
- In this research the interviewer is the same person as the person that transcribed and coded the interviews. This means that the coding may not be completely neutral and consistent, because there is no comparison possible with other coders. Therefore, qualitative multiple case research is sensitive to the researcher's subjective interpretations and the researcher should pay attention to reflecting the meanings of the results.

[2] External expert was Maarten Wijnheijmer, who is an external supervisor in this research who has experience in coaching, guiding and implementing value-based pricing within international companies.

However, to partly overcome researcher's subjectivity in the asked questions, there is chosen for a semi-structured interview method. In this method there are some guiding questions, while there is also room for follow-up questions. This is beneficial because it is more flexible and the underlying perspectives of the interviewee will appear during these interviews (Qu & Dumay, 2011). Additionally, attention is paid towards the formulation of interview questions and the interview context, because 'positive and negative item wording' is one of the examples given for the most common method biases mentioned by Podsakoff, MacKenzie, Lee et al. (2003) that may influence the interview results. So, questions are neutral formulated, mostly open-ended and collected using the same measurement context. In all cases the interview context was an online environment named 'Zoom' or 'Teams'.

For coding the interviews the Gioia methodology described in Gioia, Corley, & Hamilton (2013) was used. This means that from the interview transcriptions 1st-order categories emerged from seeking similarities and differences from the interview data. Later were the 1st-order themes connected to theoretical concepts in 2nd-order themes. Consequently, these 2nd-order themes were combined in 'aggregate dimensions' such as 'RP's price' or 'customer benefits of RP' to connect interview results to distinctive categories which can be used in the thesis results. Moreover, this Gioia method leads to a comprehensive data structure, which contributes to the transparency of the findings, but it also makes it possible to compare and assess the coding (Gioia et al., 2013). Furthermore, a 'code-recode procedure' is used to increase the dependability of the thesis, whereby the researcher codes and recodes the data several times to compare and improve the coding results (Yulianto & Krefting, 1991). Finally, the interview coding resulted in the quantification of qualitative data to improve objectivity and neutrality. The coding results can be found in Appendix 6.

Group discussion

The group and focus group discussions were held with the sales and management team of SCC. A (focus) group discussion has a lot of similarities with the interview method, However, a group discussion has some advantages, such as: time savings and less bias from the researcher, because the interviewer has a less active role during a group discussion (Qu & Dumay, 2011). This means that the interviewer bias is less in this method resulting in a higher level of neutrality, compared to the interview method.

3.4.2 Truth value

In relation to the study of Lincoln and Guba (1985), truth value is called 'credibility'. Meaning that "a qualitative study is credible when it presents such accurate descriptions or interpretation of human experience that people who also share that experience would immediately recognize the descriptions" (Yulianto & Krefting, 1991, p. 216). To increase the credibility of this research, interviews are recorded and transcribed to obtain comprehensive data that can be objectively interpreted.

3.4.3 Applicability

For a study to be applicable, the findings must be applicable to other settings, contexts, or with other people (Yulianto & Krefting, 1991). Furthermore, Yulianto & Krefting (1991) stated that "as long as the original researcher presents sufficient descriptive data to allow comparison, he or she has addressed the problem of applicability"(p. 216). As mentioned before, a case study protocol is drawn up, but interview questions are also written out and interview results are recorded, transcribed and coded, so that other researchers probably have enough information to allow a comparison.

Nevertheless, interview data is only collected through a one-time interview per customer, which means that there is no evidence for ‘analytical generalization’, as we cannot compare the research results of this study with a study for another company to see if the theory is applicable (Baškarada, 2014). Finally, this research was written specifically for SCC and its RP technique. This means that insights can be used for SCC and similar companies, but not generic to the wider industry.

3.5 Planned data analysis

The planned data analysis is to use the formed VBP framework (Figure 3, page 19) based on empirical literature to transform SCC’s current pricing approach to a VBP strategy. To do this, the process starts with ‘customer segmentation’. For this step; empirical literature, the online review and customer’s interviews are used to form an analysis to divide customers in different segments. After the ‘customer segmentation’ step the framework of Figure 3 continues. Ultimately, segment specific value propositions based on VBP are defined and implications for implementation of these VBP approaches are formulated into a pricing strategy for SCC’s RP.

3.5.1 Operationalization table

To efficiently obtain data for this research, it is necessary to know which constructs should be measured and how to operationalize these. Therefore, an operationalization table is formulated in Table 8.

Table 8 Operationalization table

Construct	Definition	Operationalization	References
Customer segmentation	Dividing customers into groups based on their purchase intentions, characteristics and the requirements or preferences they place on a product.	The customer interviews review the customer's intentions to buy RP products. Based on this information customers can be divided into 'strategic customers', 'one-off customers' and 'potential customers' (Table 9).	(Z. H. Sun, Zuo, Liang et al., 2021)
Customer value	The perceived benefits or quality a customer gets when they use the product versus the costs paid for the particular product will result in a particular attitude towards this product	Using the customer's interviews to get insights into the perceived benefits and product quality the customer received, compared to the price paid for RP products.	(Smith & Colgate, 2007)
Differentiation value	"The value of whatever differentiates the offering from the alternative" (Hinterhuber, 2004, p. 769).	The customer interviews facilitate insights in the best alternative techniques and possibly their prices, and the interviewees are asked to give reasons why they have chosen for the particular product over another.	(Hinterhuber, 2004, p. 769)
Next best alternative	The product/technique that can be used as an alternative for the product/technique in question.	Using the customer's interviews to determine which production techniques can be used as an alternative for RP.	(Hinterhuber, 2004)

Strategic customers	A customer that already has a long term relationship with SCC, or intends to create this by using RP.	Ask customers during the interviews what their purpose is with the RP products and if they intend to order series production afterwards.	
Total economic value	The total perceived value by a customer for a specific product.	This is determined to sum the 'reference value' and the 'differentiation value' of a specific product offering.	(Hinterhuber, 2004)
Value-in-use	"The presence of product / service attributes, and performances against those attributes, for which the customer is prepared to pay" (Macdonald et al., 2008, p. 2).	Using the customer's interviews to get insights into the perceived benefits and product quality the customer received, compared to the price paid for RP products.	(Macdonald et al., 2008, p. 2)
Value Proposition	A promise about a product's unique value at a specific price that is given to a specific target customer.	To articulate the value propositions for RPaaP and RPaaS the predefined formula of Hinterhuber & Snelgrove (2017) (Appendix 7) is used.	(Coppenhaver, 2018)
Quantified customer value	Expressing the customer value in a monetary amount	The obtained data from the interviews, group discussion and online review are used to fill in the quantification procedure of Hinterhuber (2004) as mentioned in paragraph 2.2.5	(Hinterhuber, 2004)
Willingness to pay	The maximum price a customer wants to pay for a certain amount of products or services.	Using the customer's interviews to determine how much a customer is willing to pay for a particular (previous) ordered product	(Le Gall-Ely, 2009)

Chapter 4: Results

In this section the results from this research are discussed. Before the VBP framework can be applied on SCC's pricing approach, SCC's current pricing approach and that of its competitors in the market are discussed to get a view of established pricing strategies of RP in industrial markets. After this, the formulated VBP framework (Figure 3, page 19) is applied to SCC's situation. This process starts with the 'customer identification analysis'. In this first step the customer segmentation, customer value analysis, and the value proposition development take place. After this stage the 'implementation of VBP' process starts. In this stage the focus lays on the development of trust, brand image and perceived value-in-use. The last step in the framework is 'verification of value'. In this stage the RP's value is assessed.

4.1 Pricing practices and value creation at SCC

4.1.1 SCC's vision on Rapid Prototyping and its value

SCC is a steel foundry in the Netherlands that operates worldwide and uses 'lost wax' or 'precision casting' techniques to produce series in steel or aluminum for distinctive industries. In addition, the firm uses 3D printing instead of molds for the production of small batches of products or for design validation. This process is called 'Rapid Prototyping'[3].

SCC's RP is changing its business model to a more service- and solution-oriented organization. RP is a way to increase the organization's product range by offering smaller quantities, but RP is also enabling the service that SCC offers to its customers to optimize and test product designs. Furthermore, RP may be a way to broaden the customer base, and therefore to be less dependent on the automotive industry. This is also a business objective for SCC because the electrification of the automotive engines forms a great risk for the future demand for steel components as supplied by SCC.

According to SCC, RP has following values for customers. When RP is used as part of a 'service' to optimize and test prototypes and to finalize designs. Firstly, the customer is able to use and optimize casted prototypes before needing to invest in wax injection molds directly, which saves costs. Secondly, the time to market for RP parts is shorter than that of 'lost wax' parts because RP parts can be produced within two months. Thirdly, RP reduces risks because there is a smaller chance of wrongly produced molds. Fourthly, there are less investments or iteration steps because the RP parts can directly be used as input for the series 'lost wax' process.

However, RP technique also has its drawbacks. The dimensioning precision of RP products is less than that of 'lost wax' products. Furthermore, RP products have lower surface quality (less smooth surfaces for instance) than 'lost wax' products. Lastly, with RP products there is less freedom of product shape and design compared to 'lost wax' products[4]. So, these are all factors that need to be taken into account when RP is offered to customers. Especially, when RP parts are used as 'end-product' by the customer.

[3] Information from SCC's website.
[4] Information from SCC's sales team.

4.1.2 SCC's current Rapid Prototyping pricing

To evaluate the pricing practices of SCC, the paper of Johansson & Andersson (2012) is used. This paper describes "pricing practices and value creation logics" (p.1). Moreover, a case study firm is used to describe how the value creation logic from literature impacts pricing practices. This firm is, similar to SCC, an industrial company that supplies highly customized products. Furthermore, SCC's current pricing strategy shares a lot of similarities with the case study firm mentioned in Johansson & Andersson (2012). For instance, SCC also offers complex customized products to its customers without using standard list prices. Moreover, SCC is also a 'one stop shop' that strives for long-term customer relationships. Additionally, the customer's prices are mainly based on; 'cost plus margin' prices, experiences of the sales managers, and previously made deals. Finally, SCC's sales managers are aware of the great customer value they deliver with the RP products, but simply do not know how to price them. To illustrate the pricing practices of RP at SCC, in Appendix 8 an example of a quote is given.

To improve SCC's pricing approach, the value models for customized products from Johansson & Andersson (2012) are used and the challenges or issues that appear during the (current) sales process are addressed[5]:

- A value analysis could be used to define, firstly, several subsets of the markets, and secondly, to define specific customer-unique demands and values which ultimately could form the basis for segment specific value propositions (Johansson & Andersson, 2012).
- To leverage the value of RP and SCC's support to optimize the design, SCC must be involved early in the procurement process (Johansson & Andersson, 2012). SCC's 'optimized design' is a sufficient way to improve this customization.
- Although SCC's optimized design creates a lot of value for customers, there is not yet a guideline within SCC when and how this value is charged to customers. On the one hand, engineering services can be a deterrent for new customers. On the other hand, in case the service is provided free of charge, customers have to be tied to SCC in some way, to avoid them from shopping with the 'optimized design' at competitors.
- SCC's proposition suggests that RP is just as important as series production. However, in view of the importance of series production to SCC's business, this is only the case when RP is used as the pre-process for the preceding series production process. So, these RP customers are preferred over customers that use RP for small series orders only.
- SCC's RP has no clear meaning in relation to casted products (see online review in section 4.2). It is a collective name for a technique that can be used for casted parts, but also for CNC machining, for example.

[5] Based on data from group discussion.

4.2 Pricing habits in the component manufacturing market

To get insights in SCC's competitors and habits in the market, an online review is conducted based on the search terms mentioned in Table 2, company names mentioned by SCC's sales team and interviewees. The results from the online review can be found in Appendix 9. Moreover, based on the online review the following conclusions could be made for RP:

- No clear pricing approach for RP can be found using the online review, because most companies do not list prices on their website and redirect visitors to the contact form.
- SCC does not once appear in the top 3 ratings of Google when using the search terms mentioned in Table 2.
- For casted prototype parts the formulated 'benefits' or 'values' that firms mention on their website are very similar to SCC's. For instance, RP "for cost and time savings", "before ordering a cost-intensive tool", "for pre-series", "for testing", "before making the mold", "has great design freedom"[6], etc.
  Additionally, because the websites of all competitors are very similar, SCC can differentiate a lot by adding 'customization' and specific customer values in their proposition.
- When the search term 'Rapid Prototyping' is used, the first three companies that appear on Google are firms that use CNC machining tools for RP. This means that the term 'Rapid Prototyping' is not specifically associated with casted parts.
- The majority of the analyzed company websites that could be found with the search term 'Rapid Prototyping' do not specifically mention the meaning of RP, or its process on their websites.
- Based on the sample from the online review the search term 'additive manufacturing' shows a low relationship with 'Rapid Prototyping', because companies with the search term 9 till 13 do not mention anything about RP.

4.3 Value-based pricing framework – Customer identification and analysis

In this section the VBP framework of Figure 3 (page 19) is used to form a suitable pricing strategy. In the following sections every step of the customer identification and analysis phase is elaborated.

4.3.1 Customer segmentation

To implement a VBP strategy, the delivered value for a product or service should be predefined for a specific segment of customers (Johansson & Andersson, 2012). Therefore, in this thesis the process starts with an effective customer segmentation. For SCC this means that the customer base is divided based on value-in-use, habits in the markets and influences of new technologies.

In this research, the segmentation of SCC's RP is based on the customer's purchase intentions and differences in value-in-use for customers. Customers that intend to order series production after the RP parts value RP differently than customers that will not order series production, and therefore do have a distinctive price sensitivity and experience with RP. So, a distinction should be made between customers who order RP parts for a (provisional) one-off order and thus use the parts as their 'end products', and customers that use RP as design approval/validation technique and input for a (later) series order. Finally, there are also customers that have ignorance about RP's capabilities or ordered RP parts at competitors, these customers are segmented as 'potential customers'.

[6] Based on Appendix 9

As its primary business objective, SCC strives to create long-term customer relationships and attract customers that intend to order series production after RP. To be able to bind these customers, a servitization approach is used in this research, because servitization is a way to create customer value by offering additional services besides the manufacturers' core business (Raddats et al., 2019). So, for customers that intend to use RP as a validation technique, or as a pre-process before series production, RP should be introduced as a 'service'; Rapid Prototyping-as-a-Service (RPaaS) rather than as a 'product'; Rapid Prototyping-as-a-Product (RPaaP). In this way, SCC can better differentiate and segment customers between the one-off customers (RPaaP), customers that intend to order series production(s) after the RP order (RPaaS) and 'potential customers'. Finally, because large series production is SCC's core business, the company strives for an order distribution of 90% RPaaS customers and 10% RPaaP customers. Below the different customer segments are explained in more detail.

Rapid Prototyping-as-a-Product

RPaaP customers could be identified as customers that order small product amounts that yield less than €250,000 per year, or customers that cannot give a commitment to a series order. Therefore, the costs involved in the RPaaP development process should be covered directly, because there is no commitment to additional purchases at SCC. Moreover, these customers are less interesting than RPaaS customers for SCC, because SCC's core business is series production. RPaaP customers can therefore be seen as 'additional', when there is time available and the opportunity costs are sufficient, then these RPaaP orders can be produced.

Therefore, the following aspects must change for SCC:

- The price for RPaaP products must be relatively high compared to RPaaS parts, because the opportunity costs should be covered and SCC wishes to have an order distribution of 90% RPaaS and 10% RPaaP.
- The image that SCC conveys will have to change, since the attention for RP and series production is now divided equally (on the website for example). In addition, it should be emphasized that RP is an important tool in the optimization process that precedes series production of casted parts, rather than a possibility to offer small product quantities.

Rapid Prototyping-as-a-Service

RPaaS customers could be identified as customers that order a (recurring) series order after the design and engineering optimization process based on RP. Therefore, a servitization approach is used for RPaaS to create additional customer value (Raddats et al., 2019). Moreover, this approach is used because services can be used to protect the traditional offering of a firm (Raddats et al., 2019). For SCC, series production is their traditional offering. So, RPaaS is used to acquire new customers, broaden SCC's portfolio in the general industry, and bind those customers to the company for the series order afterwards. Finally, a service strategy could be a way to differentiate from the competition in the market.

Nevertheless, a service strategy for RP is quite complicated. Because the value that SCC adds to the customer's product is the most when SCC creates an 'optimized design' for customers, that is suitable for input of the precision casting process, so for series production[7]. According to Sjödin et al. (2019), the customer must be complemented by formal or relational contractual arrangements to protect this kind of innovation or value capture techniques. Thus, the issue for RPaaS pricing is firstly, how to get commitment from customers to get the series order, and secondly, when the costs for 'SCC's optimized design' can be charged.

Therefore, RPaaS is based on a servitization and VBP approach. By using a Product-Service Systems (PSS) the customer can be committed to SCC for the series order. However, according to SCC, customer commitment cannot be gained before the RP order in the form of contractual arrangements, because customers firstly want to see SCC's product performance before they decide to proceed with SCC for series[8]. Nevertheless, relational arrangements are possible in the form of non-disclosure agreements (NDA). Because it can be assumed that a customer does not want to share its product design with a variety of manufacturing companies. In addition to signing an NDA, 'time' also plays an important factor. Since the creation of an 'optimized design' takes time, there is little chance that the customer will have enough time after this development process to go 'shopping' with other suppliers[9]. Moreover, this factor 'time' can be referred to as 'switching costs', how better SCC's unique resources or capabilities are to make an optimal design, for instance, the greater the customer dependency will be and therefore its switching costs (Sjödin et al., 2019).

Potential customers

According to the interviews, potential RPaaS customers could be divided into three subsegments[10]:

1. Customers that have their own test facility and therefore do not order RP parts.
2. Customers that are not familiar with SCC's possibilities and therefore have ignorance about the RP technique.
3. Customers that have ordered parts at SCC's competitors[11].

For customers that have their own test facility, SCC's RP still has advantages. Because the interviewee that describes this situation always orders series production at SCC. Therefore, SCC's RP could still be used to test the assembly process and therefore will result in time savings for this particular customer[12].

The second and third group should become familiar with firstly, SCC's RP capabilities, and secondly the competitive advantages of SCC's RP in comparison to the competitors in the market. Therefore, attention to this is given in the following section 'reputation building and communication', because this section outlines improvements for the proposition of SCC's RP in the market in more detail.

[7] Based on customer interviews.
[8] Based on focus group information.
[9] Based on focus group information.
[10] This does not alter the fact that other motives are possible for potential customers outside the sample of the interview.
[11] See figure 4
[12] Based on customer interviews and coding in Appendix 6.

Customer segmentation based on interview results – a practical example

As a practical example the customer's interviews are differentiated in Table 9. Furthermore, based on value-in-use and purchase intentions the customers are segmented in RPaaP (one-off), RPaaS (strategic) or potential customers. As shown in Table 9, strategic customers or 'RPaaS customers' represent 45.5% of the respondents. However, this sample is not representative of SCC's entire customer database. Because the majority of customers approached for these interviews were customers that were already familiar with RP products. In addition, it is likely that customers who already order series production from SCC have built a relationship with the company and are therefore more willing to participate in this interview.

Table 9 Customer segmentation based on interview results[13]

Respondent	Segment	One-off	Strategic	Potential
1.	Engineering company			X
2.	Security systems manufacturer		X	
3.	Carrier systems manufacturer		X	
4.	Process technology manufacturer		X	
5.	Nautical equipment manufacturer		X	
6.	Mechanical engineering			X
7.	Painting manufacturer		X	
8.	Oil drilling			X
9.	Design agency	X		
10.	Wheelchairs manufacturer			X
11.	Automotive manufacturer			X

In Table 9 the customer segmentation is made with the term 'strategic'. A strategic relationship means in this case: customers that (already) order series production(s) at SCC, or intend to do this (after the RP order). Moreover, customers that have a strategic relationship can be approached differently using the RPaaS strategy. The other customers, 'one-off', that only order RP parts (without series production afterwards) are approached using RPaaP. However, to use the RPaaS strategy, customers must be committed to SCC for the series production order, so that RP can be offered as a 'service'. When this is not possible, RPaaP can be used to cover all costs relating to RP directly.

Based on the input from the interviews, SCC's customers could be segmented in four segments:

A. 'RPaaS customers', that use RP for design optimization and input for (later) series production.
B. 'Potential RPaaS customers' customers that intend to use the RP technique as pre-process for series production but that are not yet familiar with RP's possibilities, or customers that already have ordered RP parts (as input for series production) at competitors.
C. 'RPaaP customers', that use RP parts as their end-products (they only order small product quantities).
D. 'Potential RPaaP customers', customers that are not yet familiar with RP's possibilities with one-time orders for small product quantities, or customers that already have ordered RP parts (for small product quantities) at competitors.

[13] Based on input from the interviews with customers.

Furthermore, in the interview sample the ‘potential customers’ are all customers that intend to use the RP technique as pre-process for series production, or are customers that already have ordered RP parts (as input for series production) at competitors. Therefore, the potential customers from the interview sample are all ‘potential RPaaS’ customers.

In Figure 4 below, the respondents of the interview are divided over the four segments to gain insight into the variety of the customers in order to develop an appropriate value proposition later in the process. From the figure it appeared that most customers are ‘RPaaS’ or ‘Potential RPaaS’ customers and that there were no ‘Potential RPaaP’ customers interviewed.

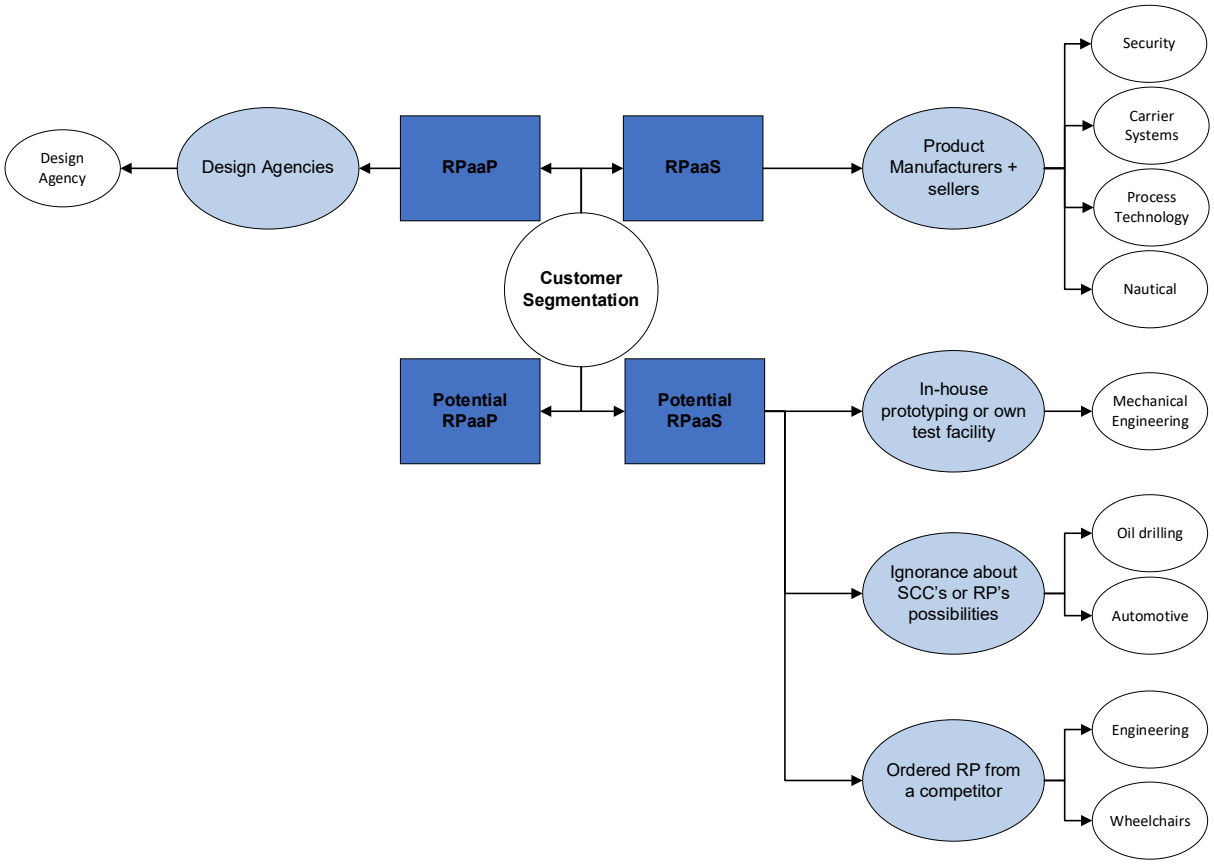


Figure 4 Customer segmentation of interview respondents

4.3.2 Customer value analysis

For the second step, a value analysis is executed based on the customer's achieved benefits of RP. To do this the input from the customer's interviews has been coded to have insights in the value-in-use of RP products (some of the interview codes can be found in Appendix 6). The results from the customer's value-in-use are summarized in Table 10 below.

Table 10 Value-in-Use of Rapid Prototyping[14]

Value-in-Use of Rapid Prototyping
1. RP makes it able to test different variants (or minor changes) of the product design (flexibility of design), to check geometry, function, strength and performance.
2. RP makes it possible to test the final material (combinations).
3. RP may avoid costs of a wrong mold, or avoids costs of adapting the series tooling, because the design is already validated.
4. RP makes smaller quantities attractive, because no investment in tooling is needed and there is no minimum purchase amount.
5. RP parts functionate as a tangible and representative product that can functionate as a sales tool to convince potential customers
6. RP reduces revisions strokes and consequently the (series) production process will be faster
7. RP has a faster delivery time because no tool has to be developed.

Since the majority of interview respondents intend to order series production after the RP order (see Table 9), the interviews also provided insights into why customers saw it as an advantage to build a strategic relationship with SCC. These arguments are listed in Table 11 below.

Table 11 Arguments for strategic relationships with SCC[15]

Reasons to order series and RP at SCC
1. Because the series price is leading, so the decision for the RP order is based on the series price.
2. Because the RP design is approved and can be delivered in the right material (combination).
3. Because SCC has collaborated in the learning process of the design.
4. Because the RP design is suitable for direct input for the series production process.
5. Because SCC's RP gives a security that no expensive changes have to be done in the mold or tooling.
6. Because the engineering costs are already paid for the RP process, and these are one-off.
7. Because SCC has proven their experience and expertise for the series production, and therefore has built a sufficient image.
8. Because SCC is a very reliable partner and we already have a very long term relationship.
9. Because SCC's core business is series production with the lost wax technique, they know how to produce suitable RP parts.
10. Because the series production cannot be interrupted, therefore RP is used for product optimizations.
11. Because RP and series production are done by SCC in the same factory.
12. Because when improvements in designs are made we always ask our 'old supplier' Because they have experience with the tooling.

[14] Based on input from the interviews with customers.

[15] Based on input from the interviews with customers.

Next best alternative technique for Rapid Prototyping

Based on the interview results it has become clear which techniques customers experience as 'alternatives' of RP. These techniques are summed below in randomly order:

- Direct 3D metal printing
- (Powder) Sintering
- CNC machining
- Sand casting
- Forging
- Welding

Additive manufacturing is both used for RP and 3D metal printing. Moreover, there are several techniques and processes that could be used for additive manufacturing of steel besides RP, such as rapid tooling, composite parts and direct part manufacturing (Gadagi & Lekurwale, 2020). Lastly, Duda & Raghavan (2016) and Gadagi & Lekurwale (2020) mention the benefits and drawbacks of additive manufacturing techniques, these are listed below in Table 12.

Table 12 Benefits and drawbacks of additive manufacturing techniques according to Duda & Raghavan (2016) *and Gadagi & Lekurwale* (2020)

Additive manufacturing techniques	
Benefits	**Drawbacks**
Tool-less manufacturing method	High production costs
High precision	Application design for setting process parameters requires considerable effort
Freedom of part design / flexibility / mass customization possible	Post-processing is needed, because of rough surface finish
Shorten time to market	Additive manufacturing techniques are relatively new and therefore may not be integrated in the production systems which prevents economies of scale
Elimination of production steps	Limited component size
Lightweight design	Support structures are necessary in the production process.
Part consolidation	The strength of 3D printed parts in Z-axes may be not as conventionally as machined parts.

Based on the information of Table 12 and the interview input, the technical capabilities of SCC's RP are set out on a scoring card, in order to give an idea of the properties of the alternative techniques, so that the competitive advantages or SCC's RP emerge. These results are shown in Table 13 below. Lastly, 'Welding' is excluded from the comparison as this technique is used for assembling parts and not necessarily for manufacturing parts.

Table 13 Scoring card for RP in comparison to 'alternative techniques'

comparison of techniques based on technical properties						
Property	**RP (using casting)**	**Metal printing**	**Sintering[16]**	**CNC machining[17]**	**Sand casting[18]**	**Forging[19]**
Low investment in tooling	+ +	+ +	- -	-	- -	- -
Lead time < 8 weeks	+ +	+ +	-	+	-	-
Reduction of validation steps	+ +	+ +	- -	+ +	- -	- -
Best product fit for series production	+ +	+	-	+ +	-	-
Design freedom	+ +	+ +	- -	- -	-	-
Surface finish	+	- -	+	+ +	+	+
Strength	+	- -	+ +	+ +	+	+ +
Lightweight design	+ +	+ +	+	+ +	- -	-
Part consolidation	+ +	+ +	+	+ +	-	+
High precision	+ +	+ +	+	+ +	- -	- -
Small component size	+ +	+ +	+	+	- -	-
Large component size	- -	- -	+	+ +	+ +	+ +
Low production costs	-	- -	+	-	+	+ +
Total[20]	17	9	1	14	0	0

At first glance it seems that RP scores very well (16). However, the 'alternative' techniques that are mentioned by the interview respondents are not all comparable to RP and its user purposes. RP and metal printing are specifically used for small precise parts in small product quantities, while sand casting and forging are less precise techniques, used for large products and quantities where a mold is necessary. Therefore, RP can best be compared to CNC machining and direct metal printing.

[16] https://en.wikipedia.org/wiki/Sintering
[17] https://en.wikipedia.org/wiki/Numerical_control
[18] https://en.wikipedia.org/wiki/Sand_casting
[19] https://en.wikipedia.org/wiki/Forging
[20] Add the '+' together and then subtract the '-'.

4.3.3 Value proposition development

The value proposition development is based on the value-in-use of the customers from the interviews. As shown in the coding results (Appendix 6), the value-in-use for RPaaP and RPaaS customers share a lot of similarities in the distinctive segments. Therefore, it is chosen to formulate two distinctive value propositions for RPaaP and RPaaS based on the 'value proposition formula' from Hinterhuber & Snelgrove (2017) (Appendix 7) together with the assessment criteria of (Coppenhaver, 2018). Further, a 'resonating focus' has been used that emphasizes the superiority of RP that are important to these target customers (Anderson et al., 2006). Below you find the two defined value propositions.

For the potential RPaaP and RPaaS customers no additional value propositions are made because these are similar to the RPaaP and RPaaS value propositions. Nevertheless, these segments deserve special attention from SCC as they provide opportunities to expand SCC's portfolio in the general industry and generate additional revenue. Therefore, in the next chapter 'Implementation of VBP', special attention is paid to these potential customers.

Value Proposition of Rapid Prototyping-as-a-Product:

For customers who place a one-time order that yields less than €250,000 per year[21], or cannot make a commitment to series production, SCC's RP provides a validated product that can be made without investment in tools, in the right material composition and with a short lead time. Unlike 3D metal printing and CNC milling, SCC does this by using a 3D printer that provides plastic or wax models that follow the same process as series production products, resulting in high quality castings[22] (Hinterhuber & Snelgrove, 2017).

Value Proposition of Rapid Prototyping-as-a-Service:

For strategic customers in need of a (recurring) series production, SCC's RP provides flexibility in design to support product design optimization, so that prototypes can be built quickly without major direct investments, in the right material composition, as well as feed into series production for rapid scale-up. This prevents multiple development iterations. Unlike CNC milling or 3D printing in steel, SCC does this by creating a dedicated process that is provisioned in series production and that works with the necessary equipment[23] (Hinterhuber & Snelgrove, 2017).

4.4 Value-based pricing framework – Implementation

For the second phase, implementation of VBP, fostering trust, building reputation and value creation and communication are important (see VBP framework in Figure 3, page 19). To foster trust and build reputation by SCC's customers, it is firstly important to know your customers. Moreover, from the customer identification process it has become clear that SCC has four customer segments, including 'potential customers'. Therefore, two routes for a suitable price for Rapid Prototyping are identified: RPaaP and RPaaS. In this section, the value creation and communication process for both segments is discussed in more detail.

[21] Quantification of value of RPaaP customers is based on input from the second focus group session.
[22] Based on interview input.
[23] Based on interview input.

4.4.1 Fostering trust and building reputation

In this paragraph the proposition of SCC's RP is identified and improvements are proposed based on the gathered data.

Firstly, to build reputation and to gain trust, the name of a tool is important. For 'Rapid Prototyping' it can be concluded that the name is not that suitable for what the process stands for. Because as identified in the customer interviews, not every customer is familiar with the term 'Rapid Prototyping' or even knows that they have bought a product made from the Rapid Prototyping process. Furthermore, the name 'Rapid Prototyping' could sound as "quick and dirty"[24] while SCC is well known in the market for their series production which is characterized as "stable and strategic" [25]. Moreover, from the online review it can be concluded that RP does not specifically stand for a casting process, but is more often used for CNC machining techniques. Finally, Rapid Prototyping represents the tool for production, while design optimization and co-engineering form the objectives of SCC[26]. So, another name for RP could be considered, for instance, a name that is connected to 'series', 'additive manufacturing', and '3D printing'. Alternatively, it can be considered to refer to 'Optimization-as-a-Service' instead of emphasizing RP. After all, RP is mainly an enabling tool for optimization and validation instead of being a value on its own.

Secondly, to gain legitimacy as a company a website is important to convince customers of your capabilities. Nevertheless, from the customer analysis it became clear that SCC's website is written in a very extensive and "technically oriented"[27] way. So, a more 'solution oriented' way is preferable to acquire new potential customers. To obtain this, recommendations are listed below:

- Mention customer solutions (for RP) on the website, instead of listing techniques with all their specifics and requirements on the websites. (This also ties in with what Hinterhuber (2008) mentions about selling solutions instead of products as mentioned in the theory section.)
- Use 'reference cases' on the website. These reference cases could be formed based on practical examples of SCC's optimized designs or RP projects, for instance. In this way customers could reflect their problems to these given examples. Consequently, these positive references contribute to SCC's image building and proposition in the market.
- Add a short introduction video of RP on the website that mentions RP's production process, RP's usages, and its benefits.

In this way, (potential) customers can become more easily familiar with SCC's possibilities and they can better compare different providers. Now there are still customers that think that SCC is only approachable for huge series orders[28], for instance.

[24] Customer quote
[25] Customer quote
[26] Based on input from the group discussion.
[27] Based on customer quotes from the interviews.
[28] Based on input from customer interviews.

Finally, it is important that RPaaS customers get priority, because RPaaS better aligns with SCC's core business and position in the casting market[29]. Therefore, RP needs to be positioned as a development tool to enable optimizing before series production, as the investment in the wax injection mold early in the design process can be a risk for customers. Moreover, RP's usage for design optimization to clarify the series production must be emphasized. Thus, the possibility to order smaller product batches (RPaaP) should be offered and communicated in a way that is subordinate to RPaaS by SCC.

4.4.2 Value creation and communication

To create and communicate the value of RP, this section primarily focuses on guidelines about what information SCC's sales team should have in advance before quoting a customer. In this way, SCC is able to effectively identify customer needs and know whether to offer RPaaS or RPaaP. This is done because a customer may have only a limited understanding of their real needs and options, so the right questions must be asked by SCC's sales team to advise the right technique and create customer value. Finally, to improve the value creation and communication of SCC's RP, some practical implications are given to optimize the quotation structure.

Value-in-Use aspects

In the customer interviews the value-in-use of customers have been identified. To implement these values in a sales tool, these customer values were discussed in focus groups. It appeared that the following aspects must be determined by SCC's sales team in advance of the RP process in order to be able to make a suitable (price) proposal:

1. Potential series order or one-off?
2. What is the time or priority of the project for the customer?
3. What is the price of the wax injection mold compared to the RP price and that of alternative techniques?
4. What is SCC's Competitive advantage?
    a. Technical capabilities
    b. Informal capabilities

Rapid Prototyping price ratio

In order to implement these questions into a working VBP sales tool, the costs of the RP parts in comparison to the costs of a wax injection mold used in series production must first be mapped out. For this, the quotes or order confirmations of the interview respondents are used. Further, the 'opinions' of the respondents about SCC's prices are used as guidelines to find a sufficient RP price / wax injection mold ratio (customer's price experience is based on coding, these results can be found in Appendix 10). Nevertheless, not all costs are known for every customer. The results are shown in Table 14.

[29] Based on input from group discussion.

Table 14 Price ratio of the RP parts and wax injection mold price

Respondent	Customer segmentation	Proto price p.u.	Wax injection mold price	Mold/proto ratio	Price experience
1.	Potential RPaaS	€ 750,00	€ 19.000,00	25,3	Fair price/cheap
2.	RPaaS	€ 152,57	Unknown		Fair price/competitive
3.	RPaaS	€ 270,00	Unknown		Expensive
4.	RPaaS	€ 1.500,00	€ 13.500,00	9,0	Fair price
5.	RPaaS	€ 215,00	Unknown		Fair price
6.	Potential RPaaS	Unknown	Unknown		It depends
7.	RPaaS	Unknown	Unknown		It depends
8.	Potential RPaaS	Unknown	Unknown		Fair price
9.	RPaaP	€ 350,00	€ 4.900,00	14,0	Fair price
10.	Potential RPaaS	€ 789,00	€ 4.740,00	6,0	Fair / expensive / it depends
11.	Potential RPaaS	Unknown	Unknown		Cheap price

As seen in Table 14, not every customer has received a proposal for RP parts and/or this in combination with a series order price. That is why some prices are unknown. Nevertheless, based on the limited data available, it could be concluded that when the mold price / RP price ratio is greater than 6, customers perceive the price as 'fair' (see results of respondent 10 in Table 14).

Quotation structure

Finally, this section provides some practical implications for SCC's current quotation structure (see Appendix 8). These are partially based on the analysis of the customer interviews. Moreover, the following changes are proposed:

- For a RP order, the quotation must contain three prices:
  - The price for the RP products and the associated engineering and printing costs should be split so that customers know what the costs are for SCC's 'optimized design'.
  - The price for the pre-series order.
  - The price for the series order, because some customers base their decision on the series (piece) price[30].
- It is important to monetize the value of SCC's 'optimized design'. Since a free optimized design can be perceived by the customer as 'little effort', or something that, because it is offered for free, is also worth 'nothing'.
- Since the costs charged for RP products are sometimes experienced as 'expensive' and not many (potential) customers know what RP means[31], it is important to mention the benefits of RP by SCC in the quotation compared to alternative techniques. For example in the form of: material savings, functionality, faster delivery, etc. In this way, customers can make better considerations between different techniques.
- For a VBP strategy, it is important to monetize the value of RP. However, since SCC's RP order is customer specific, the value of RP cannot be calculated unanimously. That is why a 'range' of percentage savings of RP compared to alternative techniques

[30] Based on customer interviews.
[31] Based on customer interviews.

will have to be considered (for example) and to mention this during customer conversations and on the quotation.
- Finally, it is important to include a 'promise' in the quotation. As discussed earlier, RPaaS customers must be tied to SCC for series production. Above all, this must result in a win-win situation. To achieve this result, for example, the costs of SCC's 'optimized design' of the RP order can be discounted from the series price. Lastly, it is important to record this mutual bond on paper.

4.5 Value-based pricing framework – Verification of value

The final step of the VBP framework mentioned in Figure 3 (page 19) is 'Verification of value'. To quantify RP's value in this section firstly the competitive advantages of SCC's RP are verified in comparison with RP's next best alternatives. After this, the value of SCC's RP is assessed. Second, value capture of SCC's RP is described using a VBP sales tool for SCC's sales. Finally, the 'knowledge management' section discusses how the insights of this research and its practical implementations could be developed further.

4.5.1 Quantification and value assessment

Rapid Prototyping versus direct metal 3D printing

In comparison to direct metal 3D printing, SCC's RP has:

- Better surface quality, because of the casting process, whereas 3D metal printing a rougher surface finish has.
- Better product strength, because RP is based on casting, while 3D metal printed products may have weaknesses in the Z-axes.
- Less expensive production costs, especially for larger product quantities. Because RP forms the pre-process for the casting process, which is mostly used for series production.
- Reduction of validation steps, because RP can be used as a pre-series process[32].

Rapid Prototyping versus CNC machining

In comparison to CNC machining, SCC's RP has:

- No investment in tooling.
- A lead time below 8 weeks.
- More design freedom or flexibility in designs.
- More abilities for smaller component sizes.

Nevertheless, CNC machining has better surface finish, products may have better strengths and CNC machining could also be used for the production of large component sizes[33].

Competitive advantages of SCC's Rapid Prototyping

Based on the interview input and the input from SCC sales team (which is summarized in Appendix 11), the following competitive advantages of RP (in combination with series production) are identified:

- RP is directly sufficient for SCC's lost-wax process. Therefore, RP has a shorter lead time because no additional validation steps are necessary.
- Furthermore, there is a shorter lead time for SCC's 'optimized design', because a parallel development of the best product fit is possible.

[32] Based on Table 13, p. 40
[33] Based on Table 13, p. 40

- When using RP, no (direct) investment in tooling is necessary, because there is a lower chance of wrong molds.
- Moreover, costs of the overall process become lower when RP is used, because there are no additional investments in engineering, because the 'optimized design' is sufficient for the lost-wax process.
- RP gives a lot of Design freedom, complex product geometries are possible.
- In the RP process blended materials can be used. Therefore, there is freedom in material combinations.
- RP results in high product quality, because the design and product are validated with RP and SCC has a lot of expertise.

Value assessment of Rapid Prototyping

SCC's RP is a customized product offering, part of a broader service (Optimization-as-a-Service), which makes it difficult to identify a specific reference technique or competitor, and therefore the reference value can be hardly calculated (Johansson & Andersson, 2012). Moreover, to quantify the value of SCC's RP, a price comparison or benchmark could be used with direct competitors of SCC which use RP in the same way, but also a comparison with RP's alternative techniques. For this, prices of direct metal 3D printing and/or CNC machining techniques could be used. However, implementing this benchmark in practice turns out to be complex for the following reasons:

- A Benchmark must be done for a variety of product designs, because RP products have a high level of customization which results in different product specifications, requirements, but also different production costs.
- Besides a variety of product designs, price comparisons should be made between SCC and its direct competitors which use the RP technique in the same way. In this way it becomes clear if the price level of SCC's RP is comparable to its competitors.
- As discussed in the theory section, Hinterhuber (2004) describes that the reference value and the differentiation value must be summed to get the total economic value; 'the value pool' for RP. To do this, SCC's RP must be compared to its 'reference techniques'; direct 3D metal printing and CNC machining. This is very time consuming because firstly, there are a variety of direct 3D metal printing techniques, secondly, there possibly is difference in the companies that offer a particular 3D metal printing technology, so these companies and their prices should also be compared, and thirdly, because of the high customization rate of the products, different designs should be compared to each other to be able to compare RP with an alternative technique. Consequently, the same difficulties probably appear when CNC machining as an alternative technique is compared to SCC's RP.

Thus, because of the high degree of complexity and the fact that performing a complete benchmark is very time-consuming, the quantification of RP's customer value is part of further research and therefore a limitation of this research.

4.5.2 Value capture

To capture the value of SCC's RP this study proposes a practical sales tool that can be used for VBP implementation of RP in Table 15. This tool provides guidelines that SCC's sales can use to create customer value in an effective way and to conduct an appropriate price for RP.

Table 15 Value-based pricing sales tool for SCC's Rapid Prototyping

Value-based pricing sales tool	
Identify customer needs	What is the purpose of this design (series / one off)? • Will the design be used for design validation? • What quantities are we talking about? What do you expect from the product in terms of performance? • What are the requirements? • In what time frame do you need the products (< 8 weeks)? Are you familiar with the lost-wax process? • Are you willing to use this process later in the production stage?
Identify type of customer	**RPaaP / Potential RPaaP:** • < € 25.000,- turnover per year. • No commitment to series order. • RP for small product amounts (sometimes). **RPaaS / Potential RPaaS** • > € 25.000,- turnover per year. • Commitment to (recurring) series order. • RP for product validation.
Select proposition (customer values Table 10 and 11)	**RPaaS:** • Flexibility in design. • To test the final blended material. • Costs and time savings in adaptation to series production (revision strokes are reduced, parallel development). • No (direct) investments in tooling. • Lower risks because of design validation. • Representative model of final product. **RPaaP:** • Production of small product batches.
Select business model	**RPaaS offer:** • Three prices: € RP, € pre-series and € series. • Promise: costs of SCC's 'optimized design' of the RP as discount of series order price. • Quantify savings (risk of wrongly produced molds, material, functionality, faster delivery, etc.) • Record mutual bond on paper (switching costs, NDA). **RPaaP offer:** • Standard quotation structure
Pricing	**RPaaS price:** • Wax injection mold ratio: > 6 * € RP **RPaaP price:** • > € Opportunity costs

4.5.3 Knowledge management

Finally, the last step of the framework; 'knowledge management' has to be kept up-to-date. Because a pricing strategy is part of the company's culture and needs to be developed in conjunction with the company to create best practices (Hinterhuber & Snelgrove, 2017). Further, customer objectives change over time, so the sales managers must 'stay hungry' and continue to explore customer needs (Hinterhuber & Snelgrove, 2017). In this way the VBP sales tool mentioned in Table 15 continually improves and adapts to current customer values and changes in the RP market.

4.6 Conclusion

In summary, the following results appeared during this research:

- RP can best be offered as part of a Product-Service System (PSS), because the identified value of RP is supporting optimization as the differentiation pre-process for series production. Therefore, the added value of RP is most with customers when RP is offered as RPaaS. So, SCC's focus must be on selling RPaaS instead of RPaaP. To achieve this, some practical implementations are suggested to improve SCC's website and market position.
- SCC's RP is an important part of the company's proposition. Since SCC's RP acts as a differentiator of the entire casting process compared to SCC's direct competitors.
- Based on both internal and external data, it can be concluded that VBP of RP is not implementing an algorithm based on a large set of data, but a process based on defining customer propositions to specific customer needs. Therefore, in this research a practical sales tool is developed that makes it possible for SCC to implement RP's VBP.

Chapter 5: Discussion

Based on literature a VBP approach is the better pricing approach for common business-to-business firms and services. A VBP approach for SCC's RP probably creates competitive advantages for the firm, because the common pricing approach within the manufacturing industry is cost-based pricing. Nevertheless, the introduction of a VBP for SCC requires (time) investments and changes in the corporate culture, which entails uncertainties that must be taken into account.

Furthermore, this research analyzed customer's perspectives to create a value analysis for SCC's RP, because for VBP the role of the customer is most important. From this data, it appeared that customers use RP in two different ways; as a validation technique for series production(s) (RPaaS), or for one-off manufacturing of smaller series, when no commitment could be given for series production (RPaaP). Moreover, RPaaS customers validate RP as an adequate technique that could be used to rapidly assess product designs, because RP products are made with high precision, in the final material application, and the same process and production plant is used as for the future series production. These aspects increase the chance that no expensive changes need to be made to molds or tooling. In this way, customers have more trust about their design, and SCC, because the parties went through the learning process together to create an optimized design. Besides that, SCC already has a good reputation and expertise with its lost-wax precision casting series production process. RPaaP customers also value the RP technique but miss all the advantages of the RP technique in connection with the lost-wax series process, because they either only need a small product quantity or cannot commit to a later series order. Since SCC's core business is lost-wax series production, RPaaS customers have preference over RPaaP customers.

Nevertheless, to answer the research question*: "What are the value propositions for RP for specific industrial markets?"* It is important to define a value proposition for both customer segments (RPaaP and RPaaS) to know which values both segments have and what their alternatives are for SCC's RP.

5.1 Value Proposition of Rapid Prototyping-as-a-Product:

For customers who place a one-time order that yields less than €250,000 per year, or cannot make a commitment to series production, SCC's RP provides a validated product that can be made without investment in tools, in the right material composition and with a short lead time. Unlike 3D metal printing and CNC milling, SCC does this by using a 3D printer that provides plastic or wax models that follow the same process as series production products, resulting in high quality castings (Hinterhuber & Snelgrove, 2017).

5.2 Value Proposition of Rapid Prototyping-as-a-Service:

For strategic customers in need of a (recurring) series production, SCC's RP provides flexibility in design to support product design optimization, so that prototypes can be built quickly without major direct investments, in the right material composition, as well as feed into series production for rapid scale-up. This prevents multiple development iterations. Unlike CNC milling or 3D printing in steel, SCC does this by creating a dedicated process that is provisioned in series production and that works with the necessary equipment (Hinterhuber & Snelgrove, 2017).

5.3 Practical implications for value-based pricing strategies

Besides a value proposition for distinctive customer segments, this research aims to answer the second research question: *"What are the practical implications for implementations of these value propositions and pricing strategies for these segments using VBP?"* Therefore, this thesis also defines a VBP strategy for RPaaS that emphasizes the important customer values for RP and that is based on a servitization approach to commit customers after the RP order to series production at SCC. For this, the term Product-Service Systems (PSS) is used. Based on this strategy a VBP sales tool is designed (Table 15, page 47) that can be used to firstly differentiate RPaaS and RPaaP customers, and secondly, gives a pricing guideline for RP based on the wax injection mold prices. In this way, the price of RP is linked to the costs that are avoided for (faulty) molds and other investments that are connected to series productions, so that RP's price can be better validated by the customer across the entire production process costs of a specific product.

Finally, RP is compared to its best alternative or reference techniques to assess RP's customer value. It seems that RP has few alternative techniques. Only direct 3D metal printing and CNC machining are suitable techniques that could be compared to SCC's RP. However, when RP is used as a pre-process or validation technique for series production, then only CNC machining is a good alternative, because direct 3D printing production costs are too expensive for larger series.

5.4 Practical implications of this research

What can businesses learn from this research? This application framework as well as the results produced provide a rich background to outline important implications. Below an overview is given:

- For this research, VBP practices are elaborated within a Business-to-business firm in the steel manufacturing and precision casting business.
- In this research, a customer's perspective is given on RP's values. Therefore, this research uses interviews to obtain insides of SCC's customers.
- Based on internal and external data collection methods, this research has identified four customer segments: RPaaP, RPaaS and potential customers for both segments. Besides this segmentation, this research also identifies the most important segments for SCC; RPaaS and its potential customers.
- For the development of a value proposition, this paper goes further than the 'customer values'. Besides looking at the customer values, or benefits, this paper investigates habits in the market, alternatives in the market, competitive advantages and the influence of new technologies.
- It appeared that the name 'Rapid Prototyping' is a collective name for a technique that uses additive manufacturing to manufacture products. This means that the technique is not specifically used for casting parts, but also for plastic and CNC machining parts, for instance. Consequently, the name 'Prototyping' is useful for RPaaS customers that use RP as pre-process for series production. However, when SCC wants to focus on RPaaP customers that use RP for their end-products, the name 'Prototyping' may be less appropriate.
- Further, practical implications are given for SCC's website and quotation structure, based on servitization aspects and the customer values related to RP.
- To practically implement VBP within the firm, a sales tool is conducted that helps SCC's sales to firstly, identify different customer segments; the RPaaS or RPaaP customers, and secondly, to define a price that is connected to investments that customers must make when they decide to order series productions; the investments in tooling or molds. In this way, it becomes clear to customers what the costs are for

the ‘risk’ they take when they immediately order series productions without design validation. So, without using the RP technique as a pre-process.

To conclude, this research contributes to the implementation of pricing practices of RP within industrial firms by creating a process for price optimization of SCC’s RP. Furthermore, this research has identified different customer segments and its connected customer values. Consequently, these insights have been used for the definition of distinctive value propositions for the customer segments. Finally, the value propositions have been used as input for the definition of VBP strategies; Rapid Prototyping-as-a-Service or Rapid Prototyping-as-a-Product. Because these two terms are not clear from an outside-in approach it is advised to reframe these value propositions from ‘inside-out solution focused’ to an ‘outside-in promise of a result’, by emphasizing that SCC is the partner of choice if a customer wants an optimized series design which results in the lowest TCO. Based on that insight, the advised VBP strategy for RP is to embed it in a broader ‘Optimization-as-a-Service’ proposition, highlighting the value of lost wax casting as a technique and the differentiating value offered by SCC as a leading supplier. In this way RP contributes to SCC’s core business.

5.5 Theoretical implications of this research

Besides the practical implications of this research, this research also contributed to VBP literature, because this is one of the few studies that sets up a framework for implementing VBP within a business-to-business context. Moreover, the imposed VBP framework (page 19) that is applied to SCC can also be applied to other businesses in a variety of industries.

Nevertheless, it should be mentioned that the VBP framework used has not yet been tested and validated in practice. In addition, there are also other existing methods that could have been used for the implementation of a VBP strategy for SCC. An entire VOC survey, for instance, that examines SCC's customers in a more extensive way and also interviews customers from different layers in organizations to get a more comprehensive picture of SCC's customer values. Second, benchmarking RP is also an option to determine the value of RP compared to alternative techniques. However, in this study it was decided to compose a separate trajectory. This is due to the fact that before a VBP strategy can be implemented within an organization, the organization must first be made ‘VBP-proof’. This means that the preliminary steps are of great importance to ultimately implement a VBP strategy. Therefore, this research has emphasized customer segmentation and value analysis that ultimately pave the way for implementing VBP.

5.6 Research limitations and further research

Due to the limited time for this research, there are some limitations or suggestions for future research to optimize the quality of this research. Below the limitations are outlined:

- The data collected from the interviews is based on one interview respondent per firm, mostly the contact person of SCC. Moreover, these results can give a distorted picture, since a buyer probably finds other things more important than, for example, a technically oriented person such as an engineer. In a follow-up study, consideration could therefore be given to a more extensive data collection in which several layers or functions of a company are discussed per 'customer'. Lastly, conducting a full VOC investigation can also be considered.
- This research further gives attention to the market proposition of RP. It appeared for instance that the name ‘Rapid Prototyping’ is a collective term for the technique. Furthermore, for RPaaP customers ‘prototyping’ is less appropriate, therefore further research is necessary for a name for ‘Rapid Prototyping’.

- To find the competitive advantages of RP in comparison to its alternative techniques, some basic research is done using sources such as Google and Wikipedia. Moreover, the 'alternative techniques' identified in this research are mentioned by interview respondents. As a consequence, the mentioned alternatives were not always a good comparison to RP, because, for instance, they are used for larger less precise parts (sand casting). Therefore, further research is necessary into comparable techniques for RP to find more precise differences.
- The VBP sales tool that is conducted for SCC's sales, might not be complete. Therefore, the tool must first be used in practice and assessment criteria should be formulated to effectively assess and improve VBP. Further, an improved strategy or tool for RPaaS could be combined with a 'pay for performance' structure to gain more commitment from the customer.
- Because of the high customization degree of RP products and other aspects such as: value-in-use, habits in the market, alternatives and the influence of new technologies, it is complex to quantify the exact values of RP. Moreover, to monetize these values, a benchmark or TCO analysis could be conducted for RP. As explained before, a benchmark must compare SCC's RP and that of direct competitors that use RP in the same way, but also the price of RP compared to alternative techniques (direct 3D metal printing and CNC machining). Because of the limited time frame of this research, there is a VBP sales tool where the price of RP is connected to the price of the wax injection mold. However, the exact quantification of RP's value is missing in this research.
- Finally, this research is carried out on behalf of SCC, which means that results and customer values are case-specific and therefore not completely generalizable. Nevertheless, the formulated framework for VBP can be applied for other B2B businesses or manufacturing companies. Lastly, to test the usability of this model, more research is needed within other companies.

Reference list

Anderson, J. C., Narus, J. A., & Rossum, W. V. A. N. (2006). *Customer Value Propositions in Business Markets*. 91–99.

Baškarada, S. (2014). Qualitative Case Study Guidelines. *The Qualitative Report*, *19*, 1–18. https://doi.org/10.46743/2160-3715/2014.1008

Ceylana, H. H., Koseb, B., & Aydin, M. (2014). Value based Pricing: A Research on Service Sector Using Van Westendorp Price Sensitivity Scale. *Procedia - Social and Behavioral Sciences*, *148*, 1–6. https://doi.org/10.1016/j.sbspro.2014.07.013

Christensen, C. M. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business Review Press. https://books.google.nl/books?hl=nl&lr=&id=K6FrJTWeUssC&oi=fnd&pg=PR4&dq=innovator%27s+dilemma&ots=3wtVVAJAeA&sig=0UujuKykDNmw3zBbep91dZR_oYw#v=onepage&q=innovator's dilemma&f=false

Coppenhaver, R. (2018). *From Voices to Results - Voice of Customer Questions, Tools, and Analysis*. Impackt Publishing Ltd.

Duda, T., & Raghavan, L. V. (2016). 3D Metal Printing Technology. *IFAC-PapersOnLine*, *49*(29), 103–110. https://doi.org/10.1016/j.ifacol.2016.11.111

Freeman, G., & Radziwill, N. M. (2018). Voice of the Customer (VoC): A Review of Techniques to Reveal and Prioritize Requirements for Quality. *Journal of Quality Management Systems, Applied Engineering, and Technology Management*, *2018*(3), 1–29.

Gadagi, B., & Lekurwale, R. (2020). A review on advances in 3D metal printing. *Materials Today: Proceedings*, *45*, 277–283. https://doi.org/10.1016/j.matpr.2020.10.436

Gaskin, S. P., Griffin, A., Hauser, J. R., Katz, G. M., & Klein, R. L. (1993). *Voice of the Customer*. 1–17. http://web.mit.edu/hauser/www/Papers/Gaskin_Griffin_Hauser_et_al VOC Encyclopedia 2011.pdf

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology. *Organizational Research Methods*, *16*(1), 15–31. https://doi.org/10.1177/1094428112452151

Gray, J. V., Helper, S., & Osborn, B. (2020). Value first, cost later: Total value contribution as a new approach to sourcing decisions. *Journal of Operations Management*, *66*(6), 735–750. https://doi.org/10.1002/joom.1113

Griffin, A., & Hauser, J. R. (1993). The voice of the customer. *Marketing Science*, *12*, 1–18. https://doi.org/10.4324/9780080496313-9

Hinterhuber, A. (2004). Towards value-based pricing - An integrative framework for decision making. *Industrial Marketing Management*, *33*(8), 765–778. https://doi.org/10.1016/j.indmarman.2003.10.006

Hinterhuber, A. (2008). Customer value-based pricing strategies: Why companies resist. *Journal of Business Strategy*, *29*(4), 41–50. https://doi.org/10.1108/02756660810887079

Hinterhuber, A., & Liozu, S. M. (2014). Is innovation in pricing your next source of competitive advantage? *Business Horizons*, *57*(3), 413–423. https://doi.org/10.1016/j.bushor.2014.01.002

Hinterhuber, A., & Snelgrove, T. C. (2017). *Value First Then Price Quantifying value in business-to-business markets from the perspective of both buyers and sellers*.

Hinterhuber, A., Snelgrove, T. C., & Stensson, B.-I. (2021). Value first , then price : the new paradigm of B2B buying and selling. *Journal of Revenue and Pricing Management*, *0123456789*. https://doi.org/10.1057/s41272-021-00304-3

Johansson, M., & Andersson, L. (2012). Pricing practices and value creation logics. *Journal of Revenue and Pricing Management*, *11*(1), 64–75. https://doi.org/10.1057/rpm.2011.43

Kriesi, C., Bjelland, O., & Steinert, M. (2018). Fast and iterative prototyping for injection molding - A case study of rapidly prototyping. *Procedia Manufacturing*, *21*(2351), 205–212. https://doi.org/10.1016/j.promfg.2018.02.112

Le Gall-Ely, M. (2009). Definition, Measurement and Determinants of the Consumer's Willingness to Pay: A Critical Synthesis and Avenues for Further Research. *Recherche et Applications En Marketing (English Edition)*, *24*(2), 91–112. https://doi.org/10.1177/205157070902400205

Macdonald, E. K., Wilson, H., & Martinez, V. (2008). Developing a framework for assessing the value-in-use of product-service systems: a case study. *EIASM 2009 Naples Forum on Service: Service-Dominant Logic, Service Science and Network Theory*, 1–20. http://medcontent.metapress.com/index/A65RM03P4874243N.pdf

Monaghan, S., & Tippmann, E. (2018). Becoming a multinational enterprise: Using industry recipes to achieve rapid multinationalization. *Journal of International Business Studies*, *49*(4), 473–495. https://doi.org/10.1057/s41267-017-0137-1

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Qu, S. Q., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting and Management*, *8*(3), 238–264. https://doi.org/10.1108/11766091111162070

Raddats, C., Kowalkowski, C., Benedettini, O., Burton, J., & Gebauer, H. (2019). Servitization: A contemporary thematic review of four major research streams. *Industrial Marketing Management*, *83*(April), 207–223. https://doi.org/10.1016/j.indmarman.2019.03.015

Raja, J. Z., Frandsen, T., Kowalkowski, C., & Jarmatz, M. (2020). Learning to discover value: Value-based pricing and selling capabilities for services and solutions. *Journal of Business Research*, *114*(April), 142–159. https://doi.org/10.1016/j.jbusres.2020.03.026

Rayna, T., & Striukova, L. (2016). From rapid prototyping to home fabrication: How 3D printing is changing business model innovation. *Technological Forecasting and Social Change*, *102*, 214–224. https://doi.org/10.1016/j.techfore.2015.07.023

Ridder, H. G. (2017). The theory contribution of case study research designs. *Business Research*, *10*(2), 281–305. https://doi.org/10.1007/s40685-017-0045-z

Sjödin, D., Parida, V., & Kohtamäki, M. (2019). Relational governance strategies for advanced service provision: Multiple paths to superior financial performance in servitization. *Journal of Business Research*, *101*(February), 906–915. https://doi.org/10.1016/j.jbusres.2019.02.042

Smith, J. B., & Colgate, M. (2007). Customer value creation: A practical framework. *Journal of Marketing Theory and Practice*, *15*(1), 7–23. https://doi.org/10.2753/MTP1069-6679150101

Snelgrove, T. (2012). Value pricing when you understand your customers: Total cost of ownership-Past, present and future. *Journal of Revenue and Pricing Management*, *11*(1), 76–80. https://doi.org/10.1057/rpm.2011.35

Sun, L., Hua, G., Cheng, T. C. E., & Wang, Y. (2020). How to price 3D-printed products? Pricing strategy for 3D printing platforms. *International Journal of Production Economics*, *226*(January), 107600. https://doi.org/10.1016/j.ijpe.2019.107600

Sun, Z. H., Zuo, T. Y., Liang, D., Ming, X., Chen, Z., & Qiu, S. (2021). GPHC: A heuristic clustering method to customer segmentation. *Applied Soft Computing*, *111*, 1–16. https://doi.org/10.1016/j.asoc.2021.107677

Töytäri, P., Keränen, J., & Rajala, R. (2017). Barriers to implementing value-based pricing in industrial markets: A micro-foundations perspective. *Journal of Business Research*, *76*, 237–246. https://doi.org/10.1016/j.jbusres.2016.04.183

Yulianto, W., & Krefting, L. (1991). Rigor in Qualitative Research: The Assessment of Trustworthiness. *Academia*, *45*(3), 214–222.

Appendix 1: The new rules of purchasing in B2B markets

Past and future best practices of B2B buying

	Past best practice	Future best practice
Main purchase criteria	Price, quality, delivery	Quality, cost, delivery, innovation, management (QCDIM) Total cost and total value of ownership Performance-based contracts
Consideration of soft factors	Generally not	Yes: sustainability, risk, agility and innovation are key differentiators for suppliers
Relationships with suppliers	Adversarial BTI/BTU (bring them in, beat them up)	Collaborative, objective is joint value creation Win-win; shared KPIs
Time horizon	Short term	Long term
Inter-company collaboration	Limited - purchasing department operates largely autonomously	High - cross functional collaboration with sales, marketing, R&D, manufacturing, finance and suppliers
Contribution	Tactical, low impact	Strategic, high impact
Main explicit assumption	Products are commodities	Suppliers are a source of innovation
Main implicit assumption	Companies compete against each other	Eco-systems compete against each other
Capabilities	Product and price	Understanding both supplier and customer value propositions, end-to-end value chain knowledge

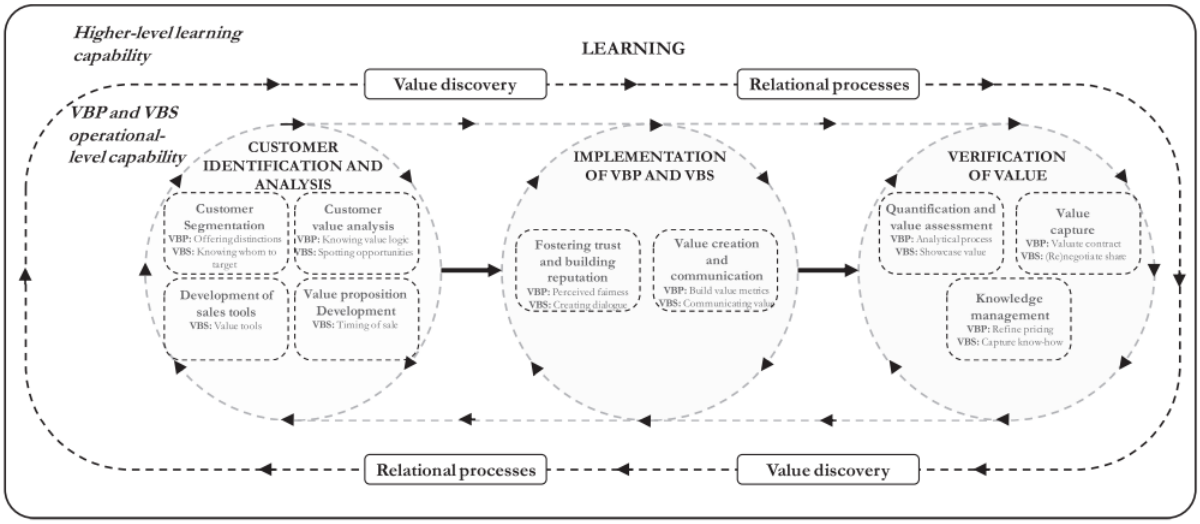
(Hinterhuber et al., 2021)

Appendix 2: Identified capabilities for Value-based pricing and selling

	Value-Based Pricing	Value-Based Selling
Customer identification and analysis		
Customer segmentation	*Offering distinctions:* Insights from customer segmentation are needed to create segment-specific value propositions and pricing structures that link customer segments to specific service offerings.	*Knowing whom to target:* Customers' technological competency and attitude toward maintenance and service activities reveal specific target segments for value-based offerings and influential stakeholder groups within target firms.
Customer value analysis	*Knowing value logic:* Understanding customer processes and operations is a means of knowing where value can be provided and charged for, rather than pricing based on costs and mark-ups.	*Spotting opportunities:* Sales personnel gain more insights from sales activities, because they have specific, detailed understanding of customers' production processes, allowing them to identify opportunities for improvement.
Development of sales tools		*Value tools:* Sales personnel should be armed with tools and devices, such as total cost of ownership analyses, animated movies, 3D scans, and models, to illustrate potential for value creation through services.
Value proposition development		*Timing of sale:* Services and solutions need to be part of the sale of products and projects (e.g., in the tendering process) with a clear outline of benefits.
Implementation of VBP and VBS		
Fostering trust and building reputation	*Perceived fairness:* Awareness of pricing fairness and the impact on customers' perceptions of the trustworthiness and reputation of the firm.	*Creating dialogue:* Develop a close dialogue with key decision makers over time by demonstrating know-how and the ability to execute projects in ways that enhance customer value.
Value creation and communication	*Build value metrics:* Develop metrics, related information systems, and routines for capturing performance enhancements to enable value creation as well as the communication of value to customers.	*Communicating value:* Ability to communicate the (potential) value created for the customer to sell and/or renew contracts.
Verification of value		
Quantification and value assessment	*Analytical process:* Processes to evaluate value delivered to the customer through service contracts and the provider's profit. Such assessments may have an impact on the KPIs and be subject to change.	*Showcase value:* Important analytical means for making delivered benefits visible to customers. Providers must quantify the results of service provision to enable value assessment.
Value capture	*Valuate contract:* Ability to receive a price commensurate with the value delivered.	*(Re)negotiate sharing:* Ability to (re-)negotiate and agree on service contracts to ensure that the price matches the customer's willingness to pay and reflects a fair share of the value created.
Knowledge management	*Refine pricing:* Ability to share and facilitate knowledge in relation to pricing aspects is key for improving a (new) offering (e.g., KPIs for gain sharing purposes).	*Capture know-how:* Ability to identify new business opportunities and create and extend sales of projects, products, and services. VBS opportunities can be identified through experiences of personnel involved in delivery of a service.

(Raja et al., 2020)

Appendix 3: Value-based pricing capability development



(Raja et al., 2020)

Appendix 4: Interview protocol and questions

Mail:

Time to market and fast development are important in industrial markets. It is important to be able to rapidly produce products according to changing customer's demands and requirements. Rapid Prototyping (RP) eases this process, because faster production is possible using 3D printing, and new products can be tested before series production; the 'safe launch-concept'. Moreover, the popularity of RP techniques (or 3D printing) increased rapidly. Nevertheless, it is not investigated yet what the exact value of RP is for its customers.

My name is Maxime Kooistra, Master Thesis student at the University of Twente, and for the next two months I will be researching the customer value of Rapid Prototyping offered by SCC.

That is why I sent this email to you, because I would like to ask you some questions relating to the value and benefits of Rapid Prototyping for customers in distinctive segments. The interview will be online via Zoom and will take about 20 minutes.

I hope that you can help me with collecting these insights. I will ensure that your names and companies remain anonymous. The data collected through these interviews will not be exploited or distributed for other purposes other than research and business insights for SCC, my commissioner who provides me the opportunity to conduct my research project.

I am looking forward to your response.

Yours Sincerely,

Maxime Kooistra

Interview introduction:

Hello, my name is Maxime Kooistra, Master Thesis student of the university of Twente, and currently I am working on my research on Rapid Prototyping pricing strategies within SCC. This interview will be used to find out what customers value about Rapid Prototyping and if SCC' prices represent the customer values.

Interview questions:

1. Can you tell me something about your relationship with SCC?
    a. How did you find SCC?
    b. What is the duration of your relationship with SCC?
    c. Why did you choose SCC (and not another firm)?
2. Why do you choose the RP technique? (which problem do you want to solve?)
    a. What is the purpose of the RP parts? (end product, to test designs)
    b. What do you expect from RP parts? (KPIs)
    c. What specific attributes and benefits do you seek when choosing a vendor? (requirements for these RP parts?)
    d. What are your achieved benefits from RP? (reduce TCO, performance, faster production → competitive advantage of SCC?)
    e. Do you have improvements for SCC's RP parts? (strengths and weaknesses)
    f. What are the alternatives of RP on the market?
    g. Do you also order series production at SCC? (are there strategic benefits?
3. What do you value about SCC's RP parts? (→ faster production, less production costs, no wrong molds, smaller product quantities?)
    a. How does SCC's RP help you achieve your goals?
    b. Is the outcome from SCC's RP parts measurable?
    c. If you have to attach a value in money to these benefits, what amount will I have to think about?
    d. What is the difference between this value at SCC and its competitors?
    e. What is SCC's competition on RP?
    f. Do you use products from the competition in the same way? (objectives)
    g. Do you see RP as a product or more as an additional service?
    h. Why?
4. What are your alternatives for RP besides SCC?
    a. Is there a difference in the quality of RP parts?
5. Are you satisfied with the purchase process with SCC?
    a. How do you describe the relationship with SCC's account manager?
    b. How does (s)he convince you to choose for SCC's RP?
    c. Does (s)he emphasize the most important aspects of RP for you? (→ resonating focus, or just common benefits?)
    d. Do you have improvements for SCC or its account manager?
6. What do you think about the paid price for the RP parts of SCC?
    a. Is it a fair price in relation to competitor's prices?
    b. What are you willing to pay for RP parts?
    c. Why?
    d. Do you think the RP price represents your achieved benefits?
    e. Why (not)?
    f. What do you pay for the alternative?
    g. Is the achieved value of SCC' RP higher? How much higher/lower?
    h. Do you have tips or improvements for SCC' pricing for RP?

Wrap-up

7. So, if I have understood this interview correctly…. 'Summarize findings'…
8. Will you recommend SCC to others?
9. Is there anything else you want to add or bring up to this interview?

End of interview

I want to thank you for your openness and time. I have recorded this interview and I will send the transcription to you for approval. Finally, I would like to emphasize that all data in the report will be anonymized.

Appendix 5: Case study protocol

This research is executed on behalf of SCC, in order to replicate this research and to obtain comparable results, a case study protocol is described in this appendix.

Data collection procedures

As mentioned in chapter 3 'research design' data is gathered from SCC using interviews, group discussions and a workshop. Further, the investigator has done an internship of three months at the company to get familiar with the sales team, the products of SCC and the production process.

Outline of the case study report

The case study research has revealed several results, such as:

- Insights on RP's value-in-use of SCC's customers (interviews).
- Insights on strategic relationships between SCC and its customers (interviews).
- Opinions of how SCC's sales and management team would like to implement VBP (group discussions).
- Opinions of what SCC's sales and management team think about the customer's value about RP (group discussions).
- Insights on how SCC's sales team approaches customers and what questions are asked during this process (group discussions).

High-level case study questions

External data was gathered using interviews with customers. The formulated questions of the conducted interviews can be found in Appendix 4. In total eleven interviews were elaborated with customers from distinctive branches. The interviews were semi-structured, so not all stated questions were asked. Lastly, probing questions were used to obtain more information about the topics mentioned by the interviewee.

The first internal data collection method was a workshop facilitated by an external expert about value-based pricing. This workshop was used to increase knowledge about value-based pricing and also as input for the group discussion. To hold a similar workshop within other organizations, or to gain access to the used slides, you can contact Maarten Wijnheijmer via maarten@savigon.nl.

To gather data from this first group discussion several exercises were used. First, the investigator shared her opinions and showed a model for two possible approaches (RPaaP and RPaaS) for RP. Moreover, reactions from the crowd were noted. Second, the audience was asked to articulate the value proposition of RP for RPaaP and RPaaS based on the guidelines of Hinterhuber & Snelgrove (2017). Third, a needs analysis for both RPaaP and RPaaS was conducted. This was done using the table below:

Product/Service Benefits	Possible Specific Customer Benefits	Possible Quantified Value to customer

Fourth, the audience of the workshop was confronted with interview results of the actual communicated value of RP to formulate (missed) opportunities for improvement of the sales process. Fifth, to extend the needs analysis for RPaaP and RPaaS the audience was asked to formulate open and closed-ended questions which they could use in conversations with (possible) customers to discuss RP's benefits and to ask commitment of customers. For this the following table has to be filled in:

Validated Product/ Service Benefits	**Alternate Product/ Service Weaknesses**	**Points-of-Difference (PoD)**	**How does the PoD benefit the customer?**	**Open-ended questions (to discuss benefit with customer)**	**Close-ended Questions (to request commitment)**

Sixth, some other results from the interviews were shared with the crowd in the form of 'Customer Quotes' to provoke reaction from the public. Lastly, a role play was organized for a RPaaP and a RPaaS customer to use the learned knowledge in practice.

Finally, the second and third internal data collection methods were two focus group sessions with SCC's sales and management team that were held during the research to obtain insights in how SCC's sales team evaluate the progress of this research and its results, and what their ideas are for the implementation of a VBP strategy for RP. These focus group inputs are reported after the sessions.

Appendix 6: Coding results from interviews

Potential RPaaS Customers	
Engineering company (interview 1)	
Value-in-use (competitor)	**Quote:**
No direct investment in mold	"We prefer not to pay the price for a series mold immediately, then we are talking about 50 to 60 thousand euros at least." (I1)[34]
No minimum purchase amount	"Rapid Prototyping will really offer a solution and is very interesting. Otherwise we are bound to a minimum purchase of, say 50 pieces." (I1)
RP to test different models	"I think that Rapid Prototyping that SCC offers will certainly be a real option for us in the future. Especially if we want to test different models and have to order different models."
RP to show representative solution	"We are really looking for ways to provide a representative solution and in the cheapest way possible. To convince our potential customer." (I1)
Potential RPaaS	**Quote:**
Series price is leading	"SCC was pushed aside as an option very quickly, as the price for series production was not attractive enough for us at the time." (I1)
Mechanical engineering company (interview 6)	
Customer Value (possible)	**Quote:**
RP for testing the assembly process	"We can maybe use it to do some further testing in the assembly process." (I6)
RP for time savings	"And normally when you are at that stage of a project where you would have some hardware for testing and it takes a lot of time in order to build a standard tool. But you can save a lot of time when you do some sort of Rapid Prototyping. Getting a part out of a printer that you can use directly." (I6)
Potential RPaaS	**Quote:**
Customer uses own test facility	"We have a test facility here at 'Company name', in 'Place' and also in the other locations, so we can do all kinds of tests in order to see if the product meets our specifications, and would be suitable to support the customers' demand for this." (I6)
Long-term customer	"I've been working with SCC almost 10 years now, because we have a pretty long term relationship with SCC way before my time started here." (I6)
Oil drilling company (interview 8)	
Customer value (possible)	**Quote:**
RP's lead time sounds promising	"And it sounds like the lead time at this point is also very good." (I8)
Potential RPaaS	**Quote:**
RP as a possible option	"Yeah, I think the Rapid Prototyping would definitely be something we would consider. I wish I had talked to 'Name account manager' before about this. But in any case, I think it would make sense to use it, because it wouldn't hurt." (I8)
Satisfied about SCC's series production	"So in other words, SCC did win the business at the end of the day, and I think that was due to high quantity. And being able to have a cheaper price at higher quantity and also quicker lead time at that higher quantity." (I8)

[34] This abbreviation means interviewee 1

RP as a possible option	“If it was a completely different part and it was huge in quantity, I think for sure it would make sense to do the Rapid Prototyping. Yeah, with the casting and I mean then it just comes down to logistics. Yes, I think.” (I8)
Wheelchair manufacturer (interview 10)	
Value-in-use (competitor)	**Quote:**
RP has a short lead time	“The lead time of Rapid Prototyping is also shorter than if you have it all milled, or when you have to assemble it from sheet metal.” (I10)
RP has a lot of design freedom	“What you miss with those other techniques is… At a certain point you lose your freedom of form. If you put together plate parts and then start milling or welding and then stick a plastic part against it. Then it's never the same.” (I10)
RP as validation technique	“Especially testing your design before transferring to a mold. That is the most important condition.” “So yes, Rapid Prototyping is mainly a design check and a kind of reality check of the manufacturability of the product functionality as far as we are concerned.” (I10)
Potential RPaaS	**Quote:**
RP as pre-process for series production	“In principle, the intention was that we would also continue with the same club to the production process after the Rapid Prototyping, because then you went through that learning process of the design together.” (I10)
Automotive manufacturer (interview 11)	
Customer Value (possible)	**Quote:**
RP’s lead time is fast	“So if you propose six or 8 weeks I think it's a good delay.”
Flexibility in design	“This point, this flexibility to change the design a bit, is very important. Because we then have the possibility to search for adaptation or improvement of the design.” (I11)
Potential RPaaS	**Quote:**
Order already series production at SCC	“Yeah, it's always for the big series.” (I11)
Adaptation of new prototypes is easier.	“And when we create a new generation of engines, we ask the old supplier to produce the prototype also. Because he can take the old tooling and can adapt this to his process line.” (I11)
SCC adapts changes in our design fast	“And when we create a new generation of engines, we ask the old supplier to produce the prototype also. Because he can take the old tooling and can adapt this to his process line.” (I11)
Collaboration with SCC for design optimization and cost reduction	“For this reason I started the development with SCC to find the design. The best design, to reduce the price, the delay and to make the perfect development.” (I11)

RPaaS Customers	
Security systems manufacturer (interview 2)	
Value-in-use	**Quote:**
RP can be offered in the final material	“We decided to go with SCC for this project. Because, the problem is that our material request is very specific. There are many companies who offer such a process but not with our material.” (I2)
RP for product validation	“Because in a standard way you have to order 500 or whatever amount and now it's possible to order one piece and that's why we also ordered an alternative in the shape because that's one of the possibilities of Rapid Prototyping. You can do one piece and another piece, and test the alternative and the differences in variances.” (I2)
Strategic collaboration	**Quote:**
RP parts must be similar to series parts	“We need these Rapid Prototyping parts because these must be very close to the final parts.” (I2)
Carrier Systems manufacturer (interview 3)	
Value-in-use	**Quote:**
No direct investment in mold	“The most important thing for us is to have a final testing round, before we have to invest in series tools because the tools are very expensive.” (I3)
Strategic collaboration	**Quote:**
RP as pre-process for series production	“No, the part was only a small change compared with the current solution we have for the series production, and after we tested it we can bring it to series production. That is the goal.” (I3)
Choose a vendor based on series production possibilities	“For Rapid Prototyping, in this case we didn't look for other possibilities, because in this case we decided first where the series parts will be made, and then it makes sense to make the prototypes at the same company.” (I3)
Process Technology manufacturer (interview 4)	
Value-in-use	**Quote:**
RP for material/product validation	“Well we now first receive 4 prototypes to test whether stainless steel works at all and whether stainless steel does not wear faster or wears too little, that is of course also possible.” (I4)
RP to test products	“Rapid Prototyping is used to see how a stainless steel cyclone will work in a factory. How long will it last?” (I4)
Strategic collaboration	**Quote:**
Series production if RP products perform as expected.	“But indeed, if we find out about those stainless steel cyclones, that they are absolutely great. Then a lot more will be produced for the series.” (I4)
Nautical equipment manufacturer (interview 5)	
Value-in-use	**Quote:**
No direct investment in molds	“We'll build a few prototypes first before moving on to series and before we want to invest in a real tool.” (I5)
Flexibility in design	“And that we can still develop and change in the proto phase, which is not possible if you use the tool already, then we're stuck with it and then we have to come up with a system around the tool that will work.” (I5)
RP has fast lead time + flexibility in design	“The speed of the project and the flexibility of the design are values of Rapid Prototyping for us.” (I5)

Strategic collaboration	Quote:
RP as pre-process for series production	“It is the intention that as soon as those tests are ready and the proto is validated to Final, that SCC will really start making the series parts with the lost wax method. And then the Rapid Prototyping piece expires in its entirety.” (I5)
Painting manufacturer (interview 7)	
Value-in-use	**Quote:**
RP for product validation	“Mainly we use Rapid Prototyping to test whether our products actually perform as they should.” (I7)
RP has fast lead time	“Of course, time is also important for RP, the faster turnaround time makes this process attractive, yes.” (I7)
RP reduces revision strokes	“Yes, and besides that it is really an advantage that the revision strokes are reduced due to Rapid Prototyping.” (I7)
Strategic collaboration	**Quote:**
RP to avoid interruption of the series process	“In addition, we often have a continuous series production running at SCC and you cannot just interrupt it. If, for example, you notice that there is about 10 to 15% product failure, then you start to think… And since you can't just stop the series process, we sometimes use Rapid Prototyping to optimize the design and look at it to see whether this works better for example. But of course we sometimes immediately decide to switch to a new mold.” (I7)
RPaaP Customers	
Design Agency (interview 9)	
Value-in-use	**Quote:**
RP for product validation	“What was especially useful about Rapid Prototyping is that you can validate your product geometry without investing in tooling, so you can learn from your model and say, 'This is all right'. Now we can start making tools.” (I9)
RP to assess final material	“And you can also do this in a material that is realistic for your final product, because we often 3D print things in plastic, to validate geometries, but that is not very useful in this case Because it is a steel construction.” (I9)
No direct investments in molds	“And of course you can use Rapid Prototyping as a validation technique to avoid investing in an expensive mold.” (I9)
One-off order	**Quote:**
No commitment for series	“Yes, that is always a difficult story for us, because we never take care of the production of things ourselves, nor do we outsource it. We are a design agency and we find out how it could be made and very occasionally we also arrange it, but 9 out of 10 times it is our customers who do the tenders with suppliers themselves.” (I9)
No commitment for series	“And in this particular case it might be a little more complex, because it's a municipality that often has real tenders and they're obligated to open it up and say: I need this part, sign up.” (I9)

Appendix 7: Value proposition formula

For … (*target customer*) that requires … (*the problem we solve*) SCC Rapid Prototyping provides … (*quantified benefits)* unlike … (the next best alternative offering). We do this by … (*how we do it*) as mentioned by … (*proof points*) (Hinterhuber & Snelgrove, 2017).

Appendix 8: SCC's Current quotation structure

Firm	*'Company name'*
Address	*'Company address'*
Zip code City	*'Company address'*
Country	*'Company country'*
To the attention of	*'Name of employee'*
SCC ref.	*'Code prototypes'*
Customer ref.	*'Part code'*
Content	*'Casting, blasting, processing, packaging'*
Date	'*Date'*

General	
Based on	*'part'*
Casting	optimized for the SCC molding process / 'Near Net Shape' design
Residual cut	0 – 2 mm, sanded away
Marking	article number and customer logo included
Material	CX27 / 1.4408 / GX5CrNiMo19-11-2 / RVS 316
Weight	t.b.a. kg
Finish	blasting Ra6,3 max
Tolerances	according to VDG P690 class D1/D2
Edit	No
Heat treatment	No
Surface finishing	Polish
Edit	

Prototyping parts

Casting parts	
Price	€ 750,00 per unit
Amount	4 pieces in one order and one delivery
Tooling costs	€ 800,00 including development and engineering
Delivery time	16 – 18 working weeks after order & design release
Size	The prototypes consist of 4 pieces: - Upper Part - Lower Part - Exhaust (no casting, will be purchased) Connecting piece 3/4" / 1/2" (standard part) No bolts, nuts, washers and O-rings included

Polish	
Price	€ 750,00 per experiment
Amount	2 to 3 provide experiments. This is determined in consultation.
Tooling costs	€ -
Delivery time	4 working weeks after the castings are ready
Size	It has been thought that the Upper and Lower part can be controlled by means of Schlepp finishes and can be polished. It is estimated that a Ra of 1.6 should be feasible and that a Ra of 0.8 being attempted to reach.

Terms of delivery	
SOP	2021
Duration	10 years
Packaging	including, in packaging supplied by customer; corrosion prevention at least 3 weeks after shipment
Terms of delivery	FCA *'Place'*
Terms of payment	30 days net
Conditions of sale	in accordance with the General Terms and Conditions of Sale and Delivery of Dutch Foundries, the most recent version can be found on the SCC website as mentioned below.
Validity period	30 days from the quotation date. Lose all previous offers with this their validity.

Kind regards,

'Name account manager'
'Function at SCC'

'Telephone number'
'Email address'

Appendix 9: Online Review

Company name	How they describe RP	Pricing	Additional information	Search term(s)
Feinguss-Blank[35]	• "Optimal surface quality" • "Cost and time savings" • "Before ordering a cost-intensive tool or samples" • "Smart planning" • "For first pre-series parts" • "First trials in the manufacturing and application process" • "You can install and test your precision casting before series production begins" • "Economical production of your small series" • "Short delivery times" • "High flexibility"	Contact form	• Investment casting is their core business • Use Lost wax technique • Have in-house mould making services. • Have fully machined prototypes made out of various materials	-
Zollern[36]	• -	Contact form	• Castings	-
Ecrimesa Group[37]	• "Metal 3D printing for prototyping" • "Short series of parts and tailored pieces" • "Fabrication of prototypes before making the mould" • "Speeding up the MIM process" • "The fabrication of short series of pieces with complex geometries" • "FDM printing" • "We have 3D printers for wax printing without die for short series and rapid prototypes with investment casting technology." • "This solution removes the barrier of producing dies in the initial phases or low quantity projects where investing in a die is a limiting factor."	Contact form	• "Own die design and manufacturing office" • Blog on website	-

[35] https://www.feinguss-blank.de/en/investment-casting/development-partner/prototyping/
[36] https://www.zollern.com/en/
[37] https://ecrimesagroup.com/

Oesterle GmbH[38]	• -	Contact page	• MIM technology • Die Casting • Investment casting • Sintering	-
Tsf Tübinger Stahlfeinguss[39]	• "Tight tolerances and high-quality surface finish for minimal bach sizes or even single pieces" • "Errors will be detected at an early stage in the design process" • "Short product development times" • "High dimension accuracy and surface finish" • "Economical production" • "Early error detection"	Contact page	• Steel investment casting • Rapid Prototyping	-
NRU GmbH[40]	• "Wax printing" • "Plastic printing" • "Tool-less production possible" • "Short delivery times possible" • "Great design freedom and complex geometries from a single mold" • "Near-net-shape with reduced mechanical processing" • "High cost-effectiveness for large quantities" • "Material selection not limited" • "High dimensional accuracy"	Contact form	• Steel investment castings • Aluminum investment castings • Investment casting = Rapid Prototyping	-
PCBWay[41] (CNC machining)	• CNC Machining parts with Rapid Prototyping • "Custom metal & plastic parts" • "CNC 3D printing"	Online price configu-ration	• Company offers 3D printing, CNC machining, Sheet metal (laser cutting, bending) and injection molding	1, 2, 3, 4, 6, 7, 8, 14, 15, 16
RapidProto-typing.NL[42]	• "SLS Laser sintering, SLA, CNC milling, FDM en vacuum casting". • "Small Series Manufacturing"	Online price configu-ration	• The website mentions a 'prototyping case' (but page is not available)	1

[38] https://www.oesterle-gmbh.com/
[39] https://tsf.de/rapid-prototyping/
[40] https://www.nru-gmbh.de/en/
[41] https://www.pcbway.com/rapid-prototyping/
[42] https://www.rapidprototyping.nl/

Jtc-machining[43]	• "3D printing Rapid Prototyping" • "CNC Machining Metal Rapid Prototypes" • "CNC Machining Plastic Rapid Prototypes" • "SLS Nylon Rapid Prototyping Making" • "SLA Resin Rapid Prototypes or Models" • "Vacuum Casting Plastic Prototypes" • "Low volume production"	Contact form	• Company makes CNC Machining, CNC Turning, Injection molding, Rapid Prototyping and Sheet metal parts	1
Protolabs[44]	• "Choose from 3D printing, CNC machining and injection moulding"	An account is needed to upload CAD files and to order parts.	• "The world's fastest Digital Manufacturing Service"	2, 3, 4, 7, 8, 9, 10, 11, 12,
TeamRapid tooling[45]	• "Have a physical model of your product to show your customers and investors." • "Market development with your product before production." • "Identify and reduce design flaws to save time and money." • "Create a multiple versions product in different colors and finishes to upgrade your products."	Contact form	• Rapid Prototyping Services Company in China • Mention case studies on their website to demonstrate their capacities	2
Facturee[46]	• -	Contact form	• "An online manufacturer with a network of more than 1000 manufacturing partners" • "We find the optimal manufacturer"	1, 4, 6, 7, 8, 15, 16
Medeko[47]	• -	Contact page	• "Investment casting" • "Machining"	6

[43] https://www.jtc-machining.com/product-category/rapid-prototyping/
[44] https://parts.protolabs.co.uk/rapid-prototyping/
[45] https://www.teamrapidtooling.com/
[46] https://www.facturee.de/en/
[47] https://www.medeko.sk/en/investment-casting

Firstpart[48]	• "We can make prototypes through CNC machining, 3D Printing, Sheet Metal Fabrication, and Urethane Casting	Contact form	• "Rapid tooling" • "Low-volume manufacturing"	7
Evergreen[49]	• -	Contact page	• "Workshops for different production procedures"	9
China Synergy Manufacturing Group[50]	• -	Contact page	• "Lost Wax Investment Casting" • "Machining, drilling & tapping, grinding, and welding" • "Mechanical polishing and chemical polishing"	9
Hubs (a Protolabs company)[51]	• -	Instant quotation possible based on design	• "Online 3D print service" • "FDM, SLS, MJF, SLA 3D printen" • Company also mentions CNC machining and Sheet metal laser cutting, bending on their website.	10
Xometry[52]	• -	Instant quotation possible based on design	• "SLS, HP MJF, FDM, SLA, Carbon DLS, Poly Jet and DMLS 3D printing techniques"	10
Eos[53]	• -	Contact page	• "Laser Sintering and Industrial 3D Printing" • "Success Stories" are mentioned on the website • "improving the customizability of new products".	11

[48] https://www.firstpart.com/Rapid_Prototyping-1.html
[49] https://www.qd-evergreen.com/workshop.html
[50] https://www.qd-evergreen.com/workshop.html
[51] https://www.hubs.com/manufacture/
[52] https://xometry.eu/en/3d-printing/
[53] https://www.eos.info/en/industrial-3d-printing/additive-manufacturing-how-it-works

			• "3D printing using DMLS technology" • "Flexible volumes and fast delivery" • "controlled material supply chain"	
SuNPe[54]	• -	Contact form	• "Tooling & Injection Molding Service" • "low-volume manufacturing" • "We can use aluminum and steel material to build the mold" • "Rapid tooling in 1-2 weeks" • Company offers: CNC Machining, vacuum casting, 3D printing, Sheet metal prototyping, Tooling & injection molding, Pressure Die Casting, Extrusion, Surface Finishing and low volume production services.	11
Etteplan[55]	• -	Contact page	• Engineering company • 3D printing • References on their website	12
Parts-to-go[56]	• -	Contact form	• "End-Use Manufacturing of Polymer Parts"	12
Steelorbis[57]	• -	-	• Daily steel prices	13
Layertec[58]	• -	Online shop	• Sell 3D printers, materials, parts	13

[54] https://sunpe.com/service-tooling_injection_molding.html
[55] https://www.etteplan.com/services/engineering/additive-manufacturing-industrial-3d-printing
[56] https://parts-to-go.com/partstogo-polymer-production-parts2
[57] https://www.steelorbis.com/steel-prices/daily-prices/
[58] https://blog.layertec.nl/metalen-onderdelen-met-een-complexe-geometrie-maak-ze-met-dfam

Tenengchina[59]	• -	Contact form	• “Cold Roll Forming Mill” • “Pipe production line”	13
Nowak[60]	• -	Contact form	• “Precision cast parts” • “Investment casting” • “Foundry” • “Lost-wax casting”	14
HordRT[61]	• “Low volume Manufacturing” • “Very fast (1-7 days)” • “Cost-efficient” • “The quantity is very small (1-20 pieces) • “Used on initial assembly or geometry design review”	Contact form	• CNC Machining • 3D printing • Urethane Casting • Sheet Metal Forming	14
Jumborax steel castings[62]	• -	Contact form	• “Customized cast steel parts” • “CNC Machining” • “Welding”	15
Industrial-man[63]	• Rapid tooling (injection molding) within 2-3 weeks.	Contact page	• “Rapid tooling” • “Rapid Injection Molding” • “CNC Milling and Turning”	16

[59] https://www.cntubemills.com/product-category/cold-roll-forming-mill/
[60] https://www.nowak.fr/en/
[61] https://www.hordrt.com/rapid-tooling-making-t-11.html
[62] https://www.jumborax.com/ppc_service/steel-foundry.html
[63] https://www.industrial-man.com/

Appendix 10: Customer's price experiences

Price experience Respondent 1	
Opinion:	**Quote:**
Fair price / cheap	"But If I look at budgets that we are currently working with, for example. Then that €750 is absolutely no problem, and €1,000 is also feasible for an important project."
Fair price	"But I think that €750 for 4 pieces is very acceptable. When I think about it now with all the knowledge I have now."

Price experience Respondent 2	
Opinion:	**Quote:**
Fair price	"It is a fair price, especially if you see SCC's engineering costs. The price is reasonable for us."
Competitive price	"The pricing was okay and that's why we got it by SCC. So if the price would be per piece like €700 for example, then I know I could get it for 550 or whatever so I could choose someone else so SCC's current price is a competitive price level for us."

Price experience Respondent 3	
Opinion:	**Quote:**
Expensive price	"Because of course at the end the Rapid Prototyping parts are still very expensive compared to the series parts and also if you compare it to sheet metal or whatever."
Expensive price	"I think this price for the 15 parts altogether, Yeah.. For this quantity was maybe quite high. If we only have like 5 parts, it's okay."

Price experience Respondent 4	
Opinion:	**Quote:**
Fair price	"because that also depends on how long the part lasts now... If it lasts as long as the Polyurethane cyclone then it is not a problem that it is also more expensive . Well, that's definitely important... So we're definitely happy with the price."

Price experience Respondent 5	
Opinion:	**Quote:**
Fair price	“So that's why Rapid Prototyping was the first to emerge because it is still somewhat affordable.”
Fair price	“It's always too expensive… No, it has to be in proportion, so I understand that with Rapid Prototyping a unit price will be slightly more expensive, but on the other hand, I don’t have to make an investment.”

Price experience Respondent 6	
Opinion:	**Quote:**
It depends	“The price that we are willing to pay for Rapid Prototyping parts depends a little bit on the pressure behind it, behind the project.”

Price experience Respondent 7	
Opinion:	**Quote:**
It depends	“We are really concerned with availability; which technique or process can we use for this specific product. And the price really depends on the situation and how fast we need it.”

Price experience Respondent 8	
Opinion:	**Quote:**
Fair price	“If the costs are fairly comparable to 3D printing the parts for testing, then yeah. Of course I think it would be worth it.”

Price experience Respondent 9	
Opinion:	**Quote:**
Fair price	“I don't remember if I thought it was expensive at the time, I think it was not that bad. I think it was an interesting option.”

Price experience Respondent 10	
Opinion:	**Quote:**
Fair price / Expensive price	“Yes, Rapid Prototyping parts are absolutely more expensive than series parts, but in the development process those are justifiable costs.”
It depends	“No, the price for Rapid Prototyping actually depends a bit on what the mold will cost. And what risk we take if we have to throw that mold away.”
Expensive price / it depends	“Rapid Prototyping is not the first route we consider, because we know that the costs are relatively high. But if the advantages outweigh this, and there are several factors, then Rapid Prototyping can be considered.”

Price experience Respondent 11	
Opinion:	**Quote:**
Cheap price	“But if you propose Rapid Prototyping in comparison with the costs for tooling then the price is too low and that makes Rapid Prototyping a good impact.”

Appendix 11: Value analysis based on SCC's own perspectives

Results from first group discussion/workshop

RPaaS:

Product/Service Benefits	Possible Specific Customer Benefits	Possible Quantified Value to customer
Right process	Only 1 product validation round	Short lead time Lower costs because of one validation round
Freedom of material	Production in the right material directly, unique properties of material.	Lower costs because of one validation round
Different variants possible	Test two types of designs Parallel development of best fit	Lower total costs Lower lead time
Knowledge of the production / design process.	1 point of contact for the entire process High quality of end product	Lower prices because the design is optimized at the beginning stage. Lower outage costs.

RPaaP:

Product/Service Benefits	Possible Specific Customer Benefits	Possible Quantified Value to customer
Shorter lead time	Products are faster available for customer	Go or no-go decision based on lead time
More choice for material	Right material for the purpose of the parts	
Lower product quantity is possible	to get the parts without being tied to a minimum product purchase.	Small (difference in purchase price) but can be the reason to get or get not the project
No investment necessary	Lower product price	€2.500 - €80.000
Complex design is possible	Fit-for-function becomes better	€5.000 >