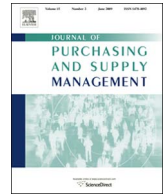




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Uncertainty perception in bidding for Product-Service Systems under competition

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ABSTRACT

This research investigates what impact of uncertainty perception arising from the existence of competition has on the pricing decision for Product-Service Systems (PSS) under uncertainty. PSS provision is an increasingly important area for many businesses and competition increases cognitive pressures on providers even further. We present an experimental study with industrial costing and bidding experts from the defence and aerospace sector. The study consisted of an experimental set-up via two questionnaires which differed in the existence of competition in the bidding scenario. The findings showed that bidding decision makers changed their evaluation of the cost estimate due to the introduction of competition but kept their evaluations of the profit margin and price bids constant. Furthermore, the participants listed the relevant sources of uncertainty that influenced their decision-making process. This research contributes to the literature in two ways. First, our findings showed that predictions from current theory regarding decision-making of cost estimation and pricing are not confirmed when competitively bidding for PSS. Second, we show uncertainty sources that influenced the decision makers and identified the importance of internal processes of the PSS provider and environmental uncertainty.

1. Introduction

Manufacturing companies increasingly adopt a servitization strategy, where services and products are integrated into Product-Service Systems (PSS) to add value for the customer (Vandermerwe and Rada, 1988; Hawkins et al., 2015; Kreye, 2017). Examples are the five year satellite support contract of the National Aeronautics and Space Administration (NASA) which is valued up to \$206 million (NASA, 2016) and the Australian Anzac Support Contract where military surface ships will be serviced for an initial period of five years (Babcock, 2012). PSS offer many advantages for providers such as increased profits, stability in cash flow and increased customer demand through lock-in situations (Wise and Baumgartner, 1999; Settanni et al., 2014). However, in practice, many of these advantages are not realised as only 21% of companies succeed with their PSS business (Baveja et al., 2004). Similarly, the literature frequently reports the financial difficulties servitized manufacturers have (Neely, 2008) with increased numbers of bankruptcies (Benedettini et al., 2015). In line with these observations, Rapaccini (2015) reports that PSS providers frequently under-price their offerings and overpromise regarding their performance because of the operational novelty and complexity of PSS for their business. Thus,

many servitized manufacturers fail to make suitable pricing decisions for their PSS offerings.

PSS contracts are typically allocated through competitive bidding against other leading suppliers in the market (Kleemann and Essig, 2013; Kreye et al., 2013) which creates various challenges for the provider's decision maker in determining a suitable price bid. On the one hand, decision makers may be encouraged to set a high price value because of the high operational uncertainty of PSS to ensure future profitability (Benedettini et al., 2015). On the other hand, the existence of competition can motivate decision makers to reduce the price bid (Feng et al., 2015; Rapaccini, 2015) leading to an under-pricing of the PSS offering. In addition, services are heterogeneous which means different providers offer different quality levels (Fisk et al., 1993). This makes offers between competitors less comparable. Furthermore, PSS are typically long-term arrangements in comparison to product sales. PSS can span, for example, five years or longer (Kreye et al., 2015) which reduces the ability to accurately forecast the cost because of increasing uncertainty of longer time horizons (Goodwin and Wright, 1993). Thus, PSS providers face high levels of uncertainty in their pricing decisions (Selviaridis and Spring, 2010; Ancarani et al., 2016).

In current practice, pricing decisions rely on the decision makers'

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judgment of the available information based on their intuition and experience to identify a suitable bid (Pemer et al., 2014; Kreye, 2016b). High levels of uncertainty negatively impact the ability of decision makers to rely on their judgment as highlighted by psychology research (Tversky and Kahneman, 1974; Ottesen and Grønhaug, 2002). Many studies describe that decision makers ignore or underestimate uncertainty which means they are overconfident in their decisions (Ancarani et al., 2016). Thus, it is the decision maker's perception of uncertainty that determines pricing decisions; however, the current servitization literature offers limited insights regarding this issue.

To address this challenge, this paper aims to investigate the following research question (RQ): What impact does the uncertainty perception arising from the existence of competition have on the providers' pricing decision for PSS under uncertainty? To answer this RQ, an empirical study is introduced to investigate the decision maker's reaction to a bidding scenario with and without the existence of competition. This is a relevant study set up because in practice many contracts in servitization are allocated in lock-in situations (Vargo, 2008; Kreye et al., 2015), where the provider engages in close and long-term relationships (i.e. without explicit competition), while other contracts are agreed in formal competitive bids as described above. The empirical study followed an experimental design and was undertaken with industrial costing and bidding experts, mainly from the defence and aerospace industry. Our research contributes to the servitization and PSS literature in two ways. First, our findings investigate decision-making at the competitive bidding stage for PSS provision and show that predictions from current theory are not confirmed within the context of PSS. Second, we show relevant uncertainty sources that influence the decision making and identify two sources that have thus far received limited attention: namely the internal processes of the PSS provider and customer related uncertainty.

2. Background

This section reviews the literature on PSS, pricing strategies for PSS and uncertainty in competitive bidding for PSS.

2.1. Product-Service Systems

Product-Service Systems integrate elements of product and service offerings so that the individual product or service part of the system cannot be distinguished anymore (Wise and Baumgartner, 1999; Kreye, 2016a). For example, for the delivery of an output-focused PSS for a fleet of aircraft, the provider may exchange the physical aircraft (or parts of it) to guarantee availability and undertake necessary, maintenance activities away from the customer site. The aircraft becomes part of the service bundle which creates an integrated offering to deliver customer value (Wise and Baumgartner, 1999). Thus, PSS have specific characteristics that distinguish them from individual product and service offerings. Specifically, the following three characteristics are important for the focus of this research.

First, PSS are heterogeneous, similar to many services, meaning that offerings differ depending on the provider and customer involved in the arrangement (Fisk et al., 1993; Lacoste and Johnsen, 2015; Kreye, 2017). The specific PSS offering depends on the provider's capabilities including the technology and knowledge they have available (Oliva and Kallenberg, 2003) and on the customer capability including their capability to provide the relevant information and access (Hawkins et al., 2015). Second, PSS offerings have typically high operational complexity which differs between specific offerings (Kreye et al., 2015). In this context, complexity can be defined as the number of independent tasks necessary to deliver the service (Benedettini and Neely, 2011). For example, the maintenance of a product or similar after-sales services require less complexity than performance-based services (Benedettini and Neely, 2011). Thus, PSS offerings require more developed and mature operational processes and delivery systems. Third, PSS are long-

lived because many of the supported pieces of equipment have long life expectancies – often spanning multiple decades (Settanni et al., 2014). Similarly, the PSS relationships for these pieces of equipment are also long-term in nature. This creates difficulties with regard to forecasting as future costs may depend on future market developments, customer's future needs and use rates as well as the provider's future capabilities (Settanni et al., 2014).

These characteristics create specific challenges for the pricing of PSS, specifically in competitive-bidding settings. PSS offerings are difficult to compare between different providers due to their non-homogeneous nature. Further, customers and providers may find it difficult to realistically evaluate the PSS offerings on the market because of the highly-complex nature of the involved operations. Finally, providers face high levels of uncertainty connected to forecasting the cost and operational need of providing a PSS, which has impact on their decision making. Thus, developing a suitable pricing strategy is a core challenge of PSS providers.

2.2. Pricing of PSS in competitive bidding

Much of the literature on competitive bidding focuses on non-integrated product or service offerings and aims typically at determining optimal bidding strategies (Cai et al., 2009; Puro et al., 2011). As described above, PSS differ from products with regard to heterogeneity of offerings between competitors, operational complexity and the long contract durations which has important implications for the pricing of these offerings. PSS prices should be determined based on the value they deliver to the customer (Oliva and Kallenberg, 2003). This value includes service quality in terms of the customer's subjective evaluation (Cronin and Taylor, 1994) that is affected by, for example, economic performance (Antioco et al., 2008), competitor offerings (Eggert and Ulaga, 2002) and customer satisfaction (Grönroos, 2011). As a result, service quality is difficult for the provider to quantify. The complexity of perception in a PSS context creates the challenge of comparison between different providers where multiple attributes apart from service price need to be considered (Ellram and Tate, 2015; Hawkins et al., 2015). These attributes depend on the specific context and can include physical facilities (Ballesteros-Pérez et al., 2016), staff skills and empathy (Kreye, 2016a) and other providers' capabilities (Roehrich and Lewis, 2014).

Much of the literature in competitive bidding has focused on services of low complexity which can be compared between providers. Examples here are delivery services (Berling and Eng-Larsson, 2016), hotel services (Ballesteros-Pérez et al., 2016) and restaurants (Arenoe et al., 2015). However, PSS include many quality elements that cannot be explicitly measured or objectively evaluated. This arises from the co-creative nature of PSS (Vargo, 2008; Khanagha et al., 2017) which depends heavily on the relationships between individual provider and customer staff (Kreye et al., 2015). As a result, many of the contract renewals are allocated in situations of non-explicit competition despite the formal setting within competitive bidding scenarios. Furthermore, many PSS span long contract durations where overall performance may only be assessed in terms of, for example, the equipment performance over its whole operational life. Thus, existing approaches have limited applicability for PSS which are highly complex, long-lived and typically non-standardised.

2.3. Uncertainty perception in pricing PSS

Uncertainty perception defines how unsure or unconfident a decision maker feels based on their perceived lack of knowledge (Kreye et al., 2012). It is affected by the comparison of a decision maker's internal model with the external world in terms of the existing uncertainty (extant uncertainty) (Tversky and Kahneman, 1974). Uncertainty perception is affected by a person's understanding of a situation (Glynn et al., 2010) as well as personal characteristics such as

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