Journal of Business Research 150 (2022) 1–11

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

Challenges in co-creating solution value during utilization phase: Insights from three failed projects

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ARTICLE INFO

Keywords:
Solution
Solution utilization
Value co-creation
Resource interaction approach

ABSTRACT

The utilization phase is critical for overall solution value creation, but solution providers and customers alike struggle to manage this phase effectively. We employed the resource interaction approach (RIA) in a case study of a Swedish clean-tech company with three failed solution projects. We identified three challenges associated with co-creating solution value during utilization: (1) new interfaces between the solution outputs and the customer's other relevant resources become manifest during use; (2) the standardized parts of the solution are created in specific contexts and hence may not perform as expected if the customer's use context is considerably different; and (3) gradual changes in the solution outputs and the customer's other relevant resources are difficult to detect and assess. We develop three propositions based on these findings. This study contributes to the solutions literature as one of the first empirical studies to investigate challenges in solution utilization from an RIA perspective.

1. Introduction

Faced with rampant commoditization, manufacturing companies are increasingly moving to differentiate themselves by offering solutions (Worm et al., 2017). By solutions, we mean customized product–service combinations that render a specific output relevant to their business customers (Nordin & Kowalkowski, 2010; Worm et al., 2017)—for example, Philips combining lighting fixtures and related services into a lighting solution that ensures energy-efficient lighting for Schiphol Airport (Ramaswamy & Pieters, 2021). Solutions are expected to deliver superior value for providers and customers alike compared with traditional, "pure" product or service offerings (Cova & Salle, 2007; Evanschitzky et al., 2011; Ulaga & Reinartz, 2011). In this article, we focus on the value of the solution for customers. Referring to Macdonald et al. (2016), we define solution value as all customer-perceived consequences arising from a solution that facilitate (or block) the achievement of the customer's goals.

Empirical studies indicate that, in fact, the solution value attained by customers often falls short of their expectations (Epp & Price, 2011; Tuli et al., 2007). The extant literature has identified certain challenges associated with creating solution value, including difficulty balancing customization and standardization levels in the solution (Foote et al., 2001; Johansson et al., 2003); understanding the customer's current and future needs for solution development (Tuli et al., 2007); and developing a shared understanding of customer expectations among multiple suppliers delivering the solution (Hakkanen & Jaakkola, 2012). However, most of the literature to date focuses on the difficulties experienced by solution providers—not customers or other actors—and relates to the solution development phase rather than the solution utilization phase (e.g., Foote et al., 2001; Johansson et al., 2003). This creates a significant gap in our understanding, as customers and other actors play important roles as co-creators of solution value (Hedvall et al., 2019; Petri & Jacob, 2016), especially during the solution utilization phase (Macdonald et al., 2016). Moreover, we find that extant studies mainly describe these challenges, failing to analyze them from a clearly defined theoretical perspective (e.g., Foote et al., 2001; Johansson et al., 2003; Tuli et al., 2007).

In response, the objective of this article is to investigate the challenges associated with co-creating solution value during the solution utilization phase. Specifically, we adopt the resource interaction approach (RIA; e.g., Baraldi et al., 2012; Bocconcelli et al., 2020; Håkansson & Waluszewski, 2002) to scrutinize these challenges. RIA, which originates from the Industrial Marketing and Purchasing (IMP) Group, focuses on studying cross-organizational resource interactions and provides concepts and tools to deal with both resource interaction processes and contextual properties related to resource interactions

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https://doi.org/10.1016/j.jbusres.2022.05.052
Received 26 February 2021; Received in revised form 16 May 2022; Accepted 21 May 2022
Available online 11 June 2022
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(Baraldi et al., 2012; Håkansson & Waluszewski, 2002, 2013). During solution utilization, the solution, as a newly added "resource" to the customer's "resource network," is supposed to "interact" with other existing resources (e.g., provided by the customer and the customer's other partners) that are "embedded" in the network to create solution value. However, these "resource interaction processes" can be challenging. Problems may arise when a new resource (e.g., the solution) is combined with other existing resources (e.g., the customer's resources) in the network and interacts with those other resources via newly generated "resource interfaces" (i.e., contact points along which two specific resources interact with or influence one another for value creation; Baraldi & Strömsten, 2006, 2008; Baraldi et al., 2011; Jahre et al., 2006; Skarp & Gadde, 2008). The four resources (4R) model, an analytical tool offered by the RIA, can be used to classify, map, and analyze the processes of resource interaction (Baraldi et al., 2012; Håkansson & Waluszewski, 2002). As indicated in the above example, the concepts commonly used in the RIA facilitate a more in-depth inquiry into the challenges of solution value co-creation during solution utilization.

In this article, we examine the following research question: *What are the challenges of co-creating solution value during the solution utilization phase?* Specifically, we aim to investigate the challenges that customers experience when utilizing a new solution that interacts with other resources in their use context. In answering this research question, we draw on the RIA and examine an in-depth case study of a Swedish cleantech company with three failed solution projects. We find three distinct challenges associated with co-creating solution value during utilization: (1) actors' limited knowledge of new resource interfaces related to solution outputs that are manifested in use and in a specific context; (2) actors' failure to identify those standardized parts of a solution that are unsuitable for a specific solution use context; and (3) actors' lack of awareness of gradual changes in resources and their implications for solution value creation. These three challenges give rise to an overarching challenge, namely actors' inability to access knowledge required for the successful resourcification of the solution and its outputs. Based on these findings, we put forward three propositions that can be tested and further developed in future studies.

This paper is structured as follows. After this introduction, we review the relevant literature and describe the methods used in this research. We then present our qualitative study and its findings, followed by our conclusions.

2. Literature review

As the concept of servitization became more widespread among manufacturing companies (Kowalkowski et al., 2017; Neely, 2008; Vandermerwe & Rada, 1988), the idea of selling solutions informed by the early literature on "systems selling" (Kowalkowski et al., 2015; Raddats et al., 2019) emerged in the 1990s. While the systems-selling literature mainly discusses value creation for suppliers (e.g., Mattsson, 1973), the solutions approach aims to create superior value for customers by customizing and integrating products and services to solve particular customer problems (Cova & Salle, 2007). Hence, understanding solution value creation is a core theme in solution studies (Jaakkola & Hakanen, 2013; Sawhney, 2006).

2.1. The challenges involved in creating solution value

The solutions literature puts forward two distinctive perspectives on creating solution value: (1) the provider-centric perspective and (2) the network-oriented perspective. According to the first, solution value is generated by the provider through customizing and integrating product and service components into a seamless whole (Evanschitzky et al., 2011; Sawhney, 2006). The second perspective posits that the provider, customer (Aarikka-Stenroos et al., 2011), and other network actors (Hakanen & Jaakkola, 2012; Windahl & Lakemond, 2006) are all involved in co-creating solution value. The first perspective accentuates the solution engineering (e.g., integration and customization) that takes place in the solution development phase as the source of solution value creation.

Although solution engineering is indeed crucial to solution value creation, this perspective has limitations. First, it is customers who determine solution value based on their assessments in accordance with their goals (Grönroos & Voima, 2013; Macdonald et al., 2016; Vargo et al., 2008). Solution engineering itself has no value for customers unless they can use the solution in their contexts to fulfill their goals. Second, this view disregards the roles of the customer and other network actors in co-creating solution value. Especially during the solution utilization phase, it is the customer (e.g., Amsterdam Schiphol Airport) who combines the solution output (e.g., energy-efficient lighting) with other resources (e.g., the design of airport shops and passenger areas) in their use environment to create value for themselves. Other network actors, such as sub-suppliers and research organizations (Windahl & Lakemond, 2006), also contribute to this process. Third, solution value evolves during the customer's use process (Grönroos & Voima, 2013) due to the changes that occur in their ongoing use over time (Macdonald et al., 2011; Skarp & Gadde, 2008). Hence, the provider-centric view that advocates solution value as embedded in the solution before use not only fails to explain the dynamics of solution value but also obstructs us from seeing it.

Multiple studies have discussed challenges in solution value creation. Identified challenges include, for example, difficulty balancing customization and standardization levels when developing a solution (Johansson et al., 2003), integrating different pieces of a solution by an external network of sub-suppliers into a seamless whole (Davies, 2004), aligning the conflicting interests of multiple suppliers when framing a solution (Hakkanen & Jaakkola, 2012), understanding the customer's present and future needs for solution development (Tuli et al., 2007), and building various firm capabilities for solution provision (Storbacka, 2011). However, the extant literature has mainly focused on depicting the difficulties experienced by solution providers, devoting limited attention to customers and other actors. Additionally, previous studies have predominantly investigated the solution development phase rather than the solution utilization phase (e.g., Foote et al., 2001; Johansson et al., 2003). Only a few studies have mentioned the challenges faced by other actors in the network (e.g., the customer) during solution utilization. This is surprising, given the importance of solution utilization for overall solution value creation (Tuli et al., 2007). When a new solution is implemented, it is not unusual to adjust it to the use context (Skarp & Gadde, 2008; Tuli et al., 2007)—and it is a challenge for all network actors to coordinate the resulting changes (Skarp & Gadde, 2008). Another challenge in this phase is that actors must interactively solve problems arising from continuously changing use conditions over time (Skarp & Gadde, 2008). Furthermore, we find that the extant solutions literature does not analyze these challenges from a clearly defined theoretical perspective but rather tends to be relatively descriptive (Johansson et al., 2003; Skarp & Gadde, 2008; Tuli et al., 2007). Without in-depth analysis of challenges from a clearly defined theoretical perspective, it is not possible to illuminate the possible root causes of the identified challenges. In the present study, we adopt the RIA to analyze the challenges involved in co-creating solution value during the solution utilization phase.

2.2. Resource interaction approach

The RIA, emanating from the IMP Group research tradition, focuses on the processes of resource interaction (i.e., the combination and utilization of resources) and expands the focus from a single firm to interorganizational networks (Baraldi et al., 2012).

Four assumptions underpin the RIA. First, the provider of a particular resource can influence only some features of this resource and hence the potential value of the resource (Snehota, 1990). The actual value of a

resource only emerges on the use side, in specific use contexts (Håkansson, 1987). Second, the networked contexts within which firms produce, utilize, and develop resources are critical for shaping the features of a resource and its economic value (Baraldi et al., 2012; Håkansson & Snehota, 1995). Third, following Penrose's (1959) concept of resource heterogeneity, the value of a resource is always dependent on the other resources with which it is combined (Håkansson, 1993; Håkansson & Snehota, 1995). Fourth, resources are open and variable objects (Baraldi et al., 2012). The value and features of resources emerge and change as they interact with other resources in the network (Håkansson & Waluszewski, 2002).

In the RIA, interactions between and across resources occur via resource interfaces: contact points along which two specific resources interact with or influence one another's technical, economic, and social features (Baraldi & Strömsten, 2006, 2008; Jahre et al., 2006). The 4R model is an analytical tool provided by the RIA for categorizing resources and analyzing their interactions and interfaces, and it is particularly useful for investigating new technology-based solutions and how they become embedded in the use context (Baraldi et al., 2011). The 4R model distinguishes among four types of resources: products (i.e., goods and services exchanged between actors); facilities (i.e., resources that actors utilize to develop, manufacture, and transport products); organizational units (i.e., resources that incorporate the knowledge, identity, and reputation of an organization); and interorganizational relationships (Baraldi & Bocconcelli, 2001; Håkansson & Waluszewski, 2002). Organizational units mobilize interorganizational relationships to organize, manage, and control products and facilities (Baraldi et al., 2012). Based on the 4R model, three types of resource interfaces are identified (Baraldi & Strömsten, 2006; Dubois & Araujo, 2006; Jahre et al., 2006): (1) technical interfaces, involving products and facilities; (2) organizational interfaces, involving organizational units and relationships; and (3) mixed interfaces, involving organizational and technical interfaces.

In the processes of resource interaction, resources shape each other's features via the resource interface to fit with each other technically (e.g., shapes and heights), economically (e.g., costs and revenues), and socially (e.g., identities and preferences) to enable value creation (Håkansson & Waluszewski, 2002). Every resource receives "imprints," which are the effects on a resource from the "pressures to develop certain other features that maybe unimportant for a focal interface, but that are necessary for satisfying the technical, social or economic requirements of other resources in order to fit better in a network context" (Baraldi et al., 2012, p. 268). Hence, each resource becomes embedded both in its individual direct interfaces and in a specific network of resources involving many indirect interfaces (Baraldi et al., 2012; Granovetter, 1992; Wedin, 2001). The longer the interactions that have combined two resources together, the greater the chance that the resources will become tightly related to each other over time at multiple levels, such as technical (Wedin, 2001), institutional (Andersson et al., 2001; Ratajczak-Mrozek, 2017), and economic (Baraldi & Strömsten, 2006). A consequence of this embeddedness is that resources become "interdependent," such that a change in the resource in combination with other resources entails economic costs (Håkansson & Snehota, 1995; Håkansson & Waluszewski, 2002, 2007).

2.3. Literature synthesis: Challenges involved in co-creating solution value in solution utilization from an RIA perspective

Drawing on the RIA, a solution—defined as customized product–service combinations that render a specific output relevant to their business customers (Nordin & Kowalkowski, 2010; Worm et al., 2017)—is a *resource*. This is compatible with the broader IMP theorizing, which considers various elements—tangible or intangible, material or symbolic—as resources if some actors identify some use for them and hence consider them valuable (Håkansson & Snehota, 1995). When relating solutions to the 4R model, it is evident that a more fine-grained appreciation of "solutions as resources" is needed. The solution is a *product* when it is exchanged between the customer and the provider. The solution becomes a *facility* when it is utilized to generate a specific output, and this output may become a further *facility* if it is utilized by the customer. Both the solution as a facility and the resulting outputs as facilities *interact* with other existing resources in the customer's use context—including facilities provided by other suppliers and organizational units such as the customer's operational processes—to create solution value.

These resources interact via resource interfaces (Baraldi & Strömsten, 2006, 2008; Jahre et al., 2006). Actors need to strive to achieve a sufficient fit between the solution and the other resources for solution value to be co-created (Baraldi et al., 2011). This fit is manifested precisely in resource interfaces, which can be technical, organizational, or mixed (Skarp & Gadde, 2008). Over time, the customer's solution use context constantly changes (Skarp & Gadde, 2008; Tuli et al., 2007) due to various factors, such as technological advancement (Tuli et al., 2007). Such changes could affect any of the relevant resources: the solution itself, its outputs, or the resources with which they interact.

Hence, the key to solution value co-creation in solution utilization is understanding how the solution and its outputs (as facilities) interact with other resources that are embedded in the solution use context over time and examining the fit between the resources in their resource interfaces on an ongoing basis. Challenges are likely to arise in the course of co-creating solution value during solution utilization if actors do not understand (a) what the solution's transition from a product to a facility entails; (b) how solution utilization gives rise to other resources; and (c) the implications of changes in the solution, its outputs, and other interacting resources over time for solution value creation.

As shown, the RIA perspective is able to shed light on the challenges of co-creating solution value during utilization. Hence, the purpose of this article is to explore the challenges from an RIA perspective.

3. Methodology

To explore the challenges involved in co-creating solution value during the solution utilization phase—a topic that has been under-researched to date—we adopted a case study method. A case study method is especially useful for conducting explorative research (Eisenhardt, 1989; Gummesson, 2000). Furthermore, investigating the challenges associated with co-creating solution value during solution utilization is a complex and context-bound pursuit. A qualitative case methodology allows us to explore a complex phenomenon within its particular context and unravel its multiple facets (Dubois & Araujo, 2004) through various data sources (Yin, 1994). This can offer highly accurate insights into organizational processes (Woodside, 2010) in addition to generating richness and in-depth understanding (Yin, 1994) of the challenges for actors associated with co-creating solution value in solution utilization.

3.1. Case selection and data collection

Many solutions studies have focused on successful solution provision exemplars (e.g., Davies, 2004; Hypko et al., 2010; Ng & Nudurupati, 2010). However, most solution providers are not so fortunate and often face a variety of challenges in the process (Johansson et al., 2003). Therefore, we deliberately sought a failed case to illuminate a novel "polar type" (Van de Ven, 2007) for solution business research. It was our assumption that, by studying unsuccessful instances, we could uncover new information about the challenges in solution value co-creation.

A longitudinal case study of three failed projects at a Swedish cleantech company, here presented under pseudonym WW, serves to illustrate the challenges of co-creating solution value during solution utilization. The case was chosen because it provides a rich illustration of

these challenges and because the three successively failed projects of a single solution context offer extensive and in-depth information related to these challenges, which allowed us to inquire deeply into their possible root causes. WW had a patented advanced oxidation technology (AOT) for water purification. To encourage local fish farmers to raise fish with recirculated water rather than flowing underground water, the government of Tianjin, China, asked WW to develop a recirculating aquaculture system (RAS) solution that incorporated the AOT. WW knew little about aquaculture but viewed this as an excellent opportunity to expand the scope of AOT applications. They soon found a Norwegian water treatment technology company, KK, who was experienced in building RASs and agreed to make an RAS for WW, substituting AOT for the typical function of the ozone in such systems. With the support of KK, WW promised the Tianjin government that it could provide a RAS solution capable of recirculating groundwater for aquaculture use. The solution included an RAS, installation, testing, and a year of technical support. In addition, WW guaranteed that the quality of the RAS-treated water would be suitable for aquaculture use.

Following recommendations from the case study research (e.g., Eisenhardt, 1989), we combined formal semi-structured interviews (13 interviews ranging from 60 to 120 min each), observations (3 days), informal conversations, and archival data as data sources for the study. Table 1 provides the details of the interviews and the interviewees.

The interviewees were identified using snowball sampling (Goodman, 1961), as this allowed us to locate knowledgeable participants in a context that was both emotionally laden (a failed case) and culturally complex (involving both European and Chinese participants). One of the main weaknesses of the snowball method is its reliance on the subjective judgments of informants (Johnson, 2014). In an effort to manage this bias, we always described the research interests and summarized the unaddressed issues to informants before asking them to recommend other respondents. This supported the informants' ability to focus on the information needs of the research project rather than reverting to their personal interests.

Direct observations complemented the interviews. One of the authors joined WW's senior manager meeting and internal RAS solution workshop. Additionally, the same author visited two customer sites in China (one in Tianjin and the other in Shandong), which involved walking around the sites, observing how the operators used the RAS solutions, and noting the discussions on solutions between the providers and customers. These direct observations provided us with information, especially in terms of the firm-level perspective on the solutions and details of how customers actually utilized the solutions.

Informal conversations played a key role in our data collection, especially when discussing the pitfalls of the RAS solutions. This provided us with richer, livelier data than could be from formal interviews. For example, in the informal conversations, people were more open to expressing their own opinions regarding the RAS solution failures. In China, people often like to discuss business in restaurants. We were not granted access to interview the customers of WW's third project; however, one of the authors was invited for a business lunch and therefore had the opportunity to ask interview questions that were prepared in advance. Notes were taken when permitted.

Table 1
Interviewee list.

Organization	Position	Interviews
Wallenius Water Sweden	RAS application VP	2
Wallenius Water Sweden	Marketing manager	1
Wallenius Water Tianjin	Sourcing and service manager	1
Wallenius Water Tianjin	General manager	2
Wallenius Water Tianjin	Mechanical engineer	1
Wallenius Water Tianjin	Electrical engineer	1
Wallenius Water Tianjin	Fish expert	2
Wallenius Water Tianjin	On-site manager	1
Wallenius Water Tianjin	Microbiologist	1
Unknown private fish farm	Owner	1

In terms of archival data, WW granted us access to their internal documents related to the study. These documents included, for example, internal business analyses, business plans, and company presentations to the government and customers. In addition, we collected archival data from various online sources (e.g., newspapers).

3.2. Data analysis

As resource interaction is a process that unfolds over time, we approached our rich empirical data using the analytical procedures outlined in existing process research (e.g., Langley, 1999; Langley et al., 2013; Van de Ven & Poole, 2005). In particular, we conducted temporal bracketing, narration, and visual mapping. Temporal bracketing allows the case data to be structured into a series of more discrete and connected blocks of activities and events (Langley, 1999; Langley et al., 2013). Through temporal bracketing, we identified three periods: the pilot solution (2011–2014), the second trial (2012–2014), and the potential showcase project at a larger customer (2014–2016). Narration was used to create detailed narratives for each of the three periods (Gersick, 1988; Langley, 1999; Van Maanen, 1995). These narrations are summarized in the below case description, and some of the associated quotes are used as illustrations in the Discussion section when we present our main findings. Visual mapping was employed (again, for each period separately) to identify the underlying mechanisms and patterns (Langley, 1999). In particular, we focused on investigating how the interactions among the RAS solution, its output, and their resource combinations in the solution use context led to failures.

4. Co-creating solution value in utilization: Three WW RAS solution projects

4.1. The pilot solution in MF

In February 2011, the head of the Tianjin Aquaculture Bureau led a team of Tianjin fish farmers to visit WW in Stockholm, Sweden. WW also invited them to visit Norwegian fish farms. The officers and farmers were very impressed by how Norwegian farmers used RASs to raise salmon in high density. After the trip, a private Tianjin-based fish farm with an annual output of 50 to 60 tons of fish, here anonymized as MF, declared itself willing to use the RAS solution on its farm to the reduce massive consumption of underground water involved in its current flowing-water system. The bureau officer decided straightaway to grant a subsidy to MF to buy one RAS from WW, hoping that more farmers would use the government's subsidy to buy and use WW's RASs based on MF's positive outcomes.

The turnkey solution sold to MF included an RAS system, installation, testing, and a year of technical support. WW further promised to guarantee that the quality of RAS-treated water (i.e., the solution output) would be suitable for aquaculture use. With the RAS solution, MF could not only save water but also raise fish in high density. MF liked the idea of raising fish in high density but doubted the deep fish pool design of the RAS, which the farmers knew would incur higher energy costs than a wide fish pool design.

In March 2012, the RAS was installed in MF. Everyone was very excited about the new system and had high expectations for its performance. MF appreciated the water-saving effect of the RAS solution. However, after three months, to the astonishment of both WW and MF, the fish began dying in the tanks. WW tested the water parameters, with satisfactory results. The representatives of MF became very upset, as they had raised the same species of fish in the flowing-water system without issue. They requested that WW take action to stop the fish from dying. However, WW could neither explain the reason for this disaster nor suggest how to deal with it, as the company had very limited knowledge of aquaculture. MF was surprised and disappointed by these turns of events. When MF put medicines into the fish tanks, as they were

accustomed to doing, even more fish died shortly afterward. After waiting for some days, the situation became increasingly worse. MF finally chose to give up, as the operational costs of the RAS were very high and they could not stop fish from dying in the RAS tanks. Thus, the company shut down the RAS and switched back to the flowing-water system. WW began to realize that there were many other factors that could affect fish mortality, such as the quality of fish eggs, fish feed, and workshop protocols. For example, their staff reported poor fish workshop conditions and inadequate protocols at MF. However, WW did not have proper knowledge of these factors, even though these factors were related to the solution use.

4.2. A second trial

In May 2012, before the problems arose at MF, Mr. Xu, a private Tianjin-based fish farmer, decided to buy an RAS solution similar to MF's to reduce underground water consumption in his fish farm. Xu operated mainly with his own money, rather than government funding, and aspired to one day successfully raise fish in the RAS, as his overseas colleagues did. Using an RAS would alleviate his concerns that the government would start charging fish farms for the use of underground water in the future. In March 2014, the RAS system was handed over to Xu. This time, WW made some modifications to the original design by KK (the Norwegian water treatment technology company), as it turned out that KK's design was not practical from an after-service perspective (e.g., RAS components only supplied from the EU) and made several severe mistakes (e.g., selecting the wrong types of pumps). The WW service team trained the workers on Xu's fish farm on how to use the systems. However, they found that the workers did not pay sufficient attention to their instructions. To facilitate the customer's use of the system, the service team visited the site almost every week. They found the use environment was "astonishingly" poor at Xu's workshop—for example, operators entering workshops without changing clothes and thereby increasing the risk of infections.

Xu raised sheta fish in the RAS and was, like MF, satisfied with the water-saving effect of the RAS. He believed that flowing-water systems would become unprofitable for the fish farmers once the government began charging for groundwater. However, after three months, the fish again started dying in the tanks. WW tested the water parameters, which again were without issue, as had been the case with MF. Xu had raised the same species of fish in the flowing-water system, and those fish had not died. Xu put medicines into the RAS fish tanks, as he was used to doing, but all the fish died shortly thereafter. The microbiologist from WW sent a water sample and fish sample to research authorities in China, but they could not identify the causes of the fishes' deaths. All in all, Xu's experiences with the RAS were strikingly similar to MF's.

WW realized that fish disease presented the greatest challenge for local fish farmers. Bacteria could come from various sources: water, fish feed, fish eggs, or operations. On European fish farms, workers change into work clothes and access to fish farms is strictly controlled, whereas on Chinese farms, almost anyone can come into the workshop. Furthermore, in China, fish eggs and fish feed are commonly procured without quality control due to cost considerations. From Xu's perspective, WW's design team lacked practical experience, was unfamiliar with the RAS, and knew little about Chinese fish farmers' business logic. For example, WW insisted on digging deep fish tanks to allow for high fish density. Xu thought that this was unnecessary because land in China is much cheaper than in Europe. Another major drawback of this design was the increased energy costs incurred by the deep pools. Similarly, the system used an electric heat pump to heat the water in the winter, yet farmers in Tianjin could easily heat water with geothermal energy without additional energy costs. Xu estimated that the annual extra energy cost caused by the design amounted to more than 60,000 RMB. While using the RAS, Xu continued modifying the system to reduce unnecessary operational costs.

4.3. A potential showcase: HY project

In October 2013, WW received a grant from the Swedish government agency for innovation (VINNOVA) to fund one RAS to help WW establish its business in China. Learning from their previous experiences with small private Chinese fish farms, this time WW persuaded a large fish farm, HY, to buy one RAS solution. In return, the customer would receive another RAS for free, funded by the VINNOVA grant. HY is a well-known fish farm located in the Shandong province and is a public–private joint-stock company. The Yellow Sea Fisheries Research Institute—the top aquaculture research association in China—holds 30% of the shares in the company. HY has more than 50,000 m^2 of fish-farming pools and was one of the first fish farms to use an RAS in China. WW hoped that this project would become their primary reference case in China, as HY was experienced in using the local RAS and also was much more professional and advanced than their previous customers. The RAS solution offered to HY was similar to the previous solutions delivered by WW, but for this project, WW's fish expert made further modifications to the RAS system design to ensure fish welfare in the RAS water (i.e., solution output). Unexpectedly, HY was not satisfied with WW's design of the system, especially the deep fish pool design, due to cost and fish disease considerations. WW insisted on their design, as they believed HY would benefit from the design by raising fish in high density.

In July 2015, the two RAS systems were handed over to HY. At that time, the moving bed biofilm reactors (MBBR), which are a standard part of the RAS systems, were not fully ready. It takes time to grow the necessary bacteria in the MBBR, but in this particular instance, HY could not delay starting to use the systems, as important visitors would shortly be coming to their site. After receiving approval from WW's fish expert, HY transferred fish into the RAS systems. Within 20 days, the fish began dying in the tanks. HY became very anxious, and, to make things worse, WW's fish expert was away for 10 days. Finally, the customer decided to put medicines into the RAS, as they often did in the flowing-water and local RAS systems. After HY did so, the fish died even more rapidly.

This bad news was met with astonishment at the WW HQ in Sweden. Eventually, WW identified six reasons for the disaster. Initially, WW had believed that fish disease caused the disaster because all the recorded water parameters were acceptable. If the WW RAS had caused the issue, it would be a systemic problem, and thus one would expect the fish to all die at the same time; however, the fish died over a period of time. The French expert dissected the fish and found that they were infected with at least two diseases. This evidence convinced WW that the fish died from diseases they had before being transferred into the RAS. They learned that there were only a few fish vaccines available in China, which, in turn, could be the reason for the fish diseases. When the fish grew bigger, their volume occupied a larger share of the fish tank. This would increase the fishes' stress levels, potentially leading to a breakout of the pre-existing diseases. Thus, the lack of fish vaccines was deemed the first cause contributing to the failure. Second, the immature MBBR released large amounts of nitrogen, contributing to the flare-up of the above-mentioned fish diseases. Third, compared with the local RAS and the flowing-water systems, the WW RAS had a low rate of water exchange, which caused the infections to spread rapidly; as soon as some fish got sick, the pathogens would spread quickly to other fish as the water exchanged slowly. Fourth, WW's RAS had a high level of automation designed to be adjusted or triggered by biological methods occurring spontaneously in the fish tanks. For example, in the MBBR of the WW RAS, activated bacteria would form biofilms to dissolve pollutants in the water. However, when fish farmers put medicines into the WW RAS systems, this destroyed the stable ecological system, and the situation worsened rather than improved. Fifth, the WW RAS environment is relatively closed; therefore, the added medicines remained in the system and also affected the healthy fish. In contrast, the local RAS had a high-level water-exchange rate and was not highly automated. It could tolerate the farmers using "special methods" (i.e., putting antibiotics

into the system) to treat the sick fish. Finally, WW found that Chinese fish farm management protocols were poor. For example, anyone could enter the fish workshop without changing clothes. Furthermore, the quality of fish feed, which could be a potential source for bacteria, was not controlled.

After the incident in which all the fish in the WW RASs were left dead, HY insisted on raising fish by using the WW RAS with very low fish density. This decision was based on the concerns HY had about the system's performance-to-price ratio. HY thought that increasing fish density would heighten the risk of fish disease and slow down the growth rate of the fish. It was hard to say objectively whether a higher density could lead to a more profitable business because this hinged on various factors. For example, in Europe, there is a daily market for fish, so fish farmers can sell fish every day. Therefore, the WW RAS was designed to produce high fish output regularly. In China, a great deal of fish is sold during Chinese New Year and other festivals. Thus, the high-density design is not necessary. In addition, land, material, and human costs are higher in Europe than in China, which makes it more profitable to raise fish with high density in Europe.

4.4. Analysis of three failed projects

The above case descriptions reveal two recurring patterns that indicate the challenges for co-creating RAS solution value in the Chinese farmers' use contexts. The first pattern concerns fish dying in the RAS water. The traditional method of raising fish involved combining the flowing water (generated by the flowing-water system) with unvaccinated fish eggs (as few fish vaccinations are approved by the Chinese food and security bureau), fish feed, and local workshop protocols. Although the fish may get sick during this traditional process, the farmers can address this by adding antibiotics to the flowing water. When the farmers changed to the RAS water (continuously guaranteed by WW through integrating the RAS system and services), combined with the same resources as those used with the flowing-water system, the fish started dying after three months (as in the first two projects). Adding antibiotics to the RAS water, as shown in all three projects, led to more fish dying immediately in the RAS water (see Fig. 1).

The second pattern relates to the disputes over the RAS system design, particularly the fish pool design. All farmers found that WW's RAS system design incurred unreasonably high operational costs that hindered them from creating solution value. They felt that the design did not take into account the Chinese farmers' use context (e.g., low labor and land costs, unstable market demand). Informed by European farmers' use context (e.g., high labor and land costs, stable market demand), WW insisted that the deep fish pool design would increase farmers' value creation, as it allowed the farmers to raise fish in high density (see Fig. 2).

5. Discussion

5.1. Challenge one: New resource interfaces related to solution output that manifest themselves in use and in a specific context

In the case, WW's RAS solution was supposed to generate clean RAS water with a low rate of water exchange to solve the Chinese farmers' problems related to water cleanliness and use. WW was indeed able to ensure the quality of the RAS water as well as low water consumption. However, the use of the RAS solution gave rise to another, even more serious problem for the farmers: fish dying in the RAS systems. The root cause for the new problem was the existence of "unfit" between the RAS water (i.e., the solution output) and the resources interacting (e.g., the workshop protocol, fish eggs, and fish feed) via their newly generated interfaces. WW's senior manager stated:

> *We had no knowledge of aquaculture when we entered into this business. We are a company in the field of water treatment. We assumed that if the water was fine, then the fish would be fine as well, but we were wrong. There were so many other factors we identified later that would affect fish mortality, such as the quality of fish eggs and workshop protocols.*

The fish farmer Mr. Xu reflected on the fish death disaster and

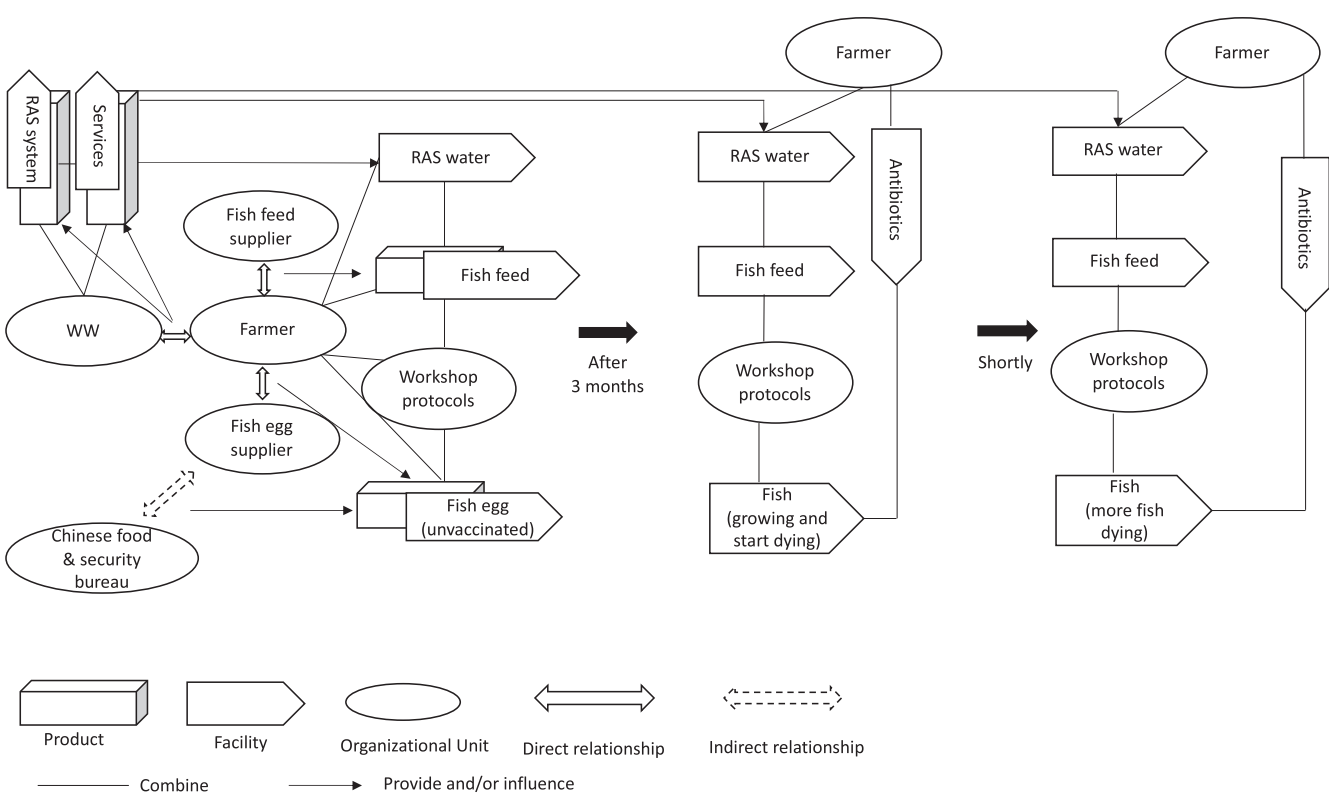

Fig. 1. Pattern of fish dying in the RAS water.

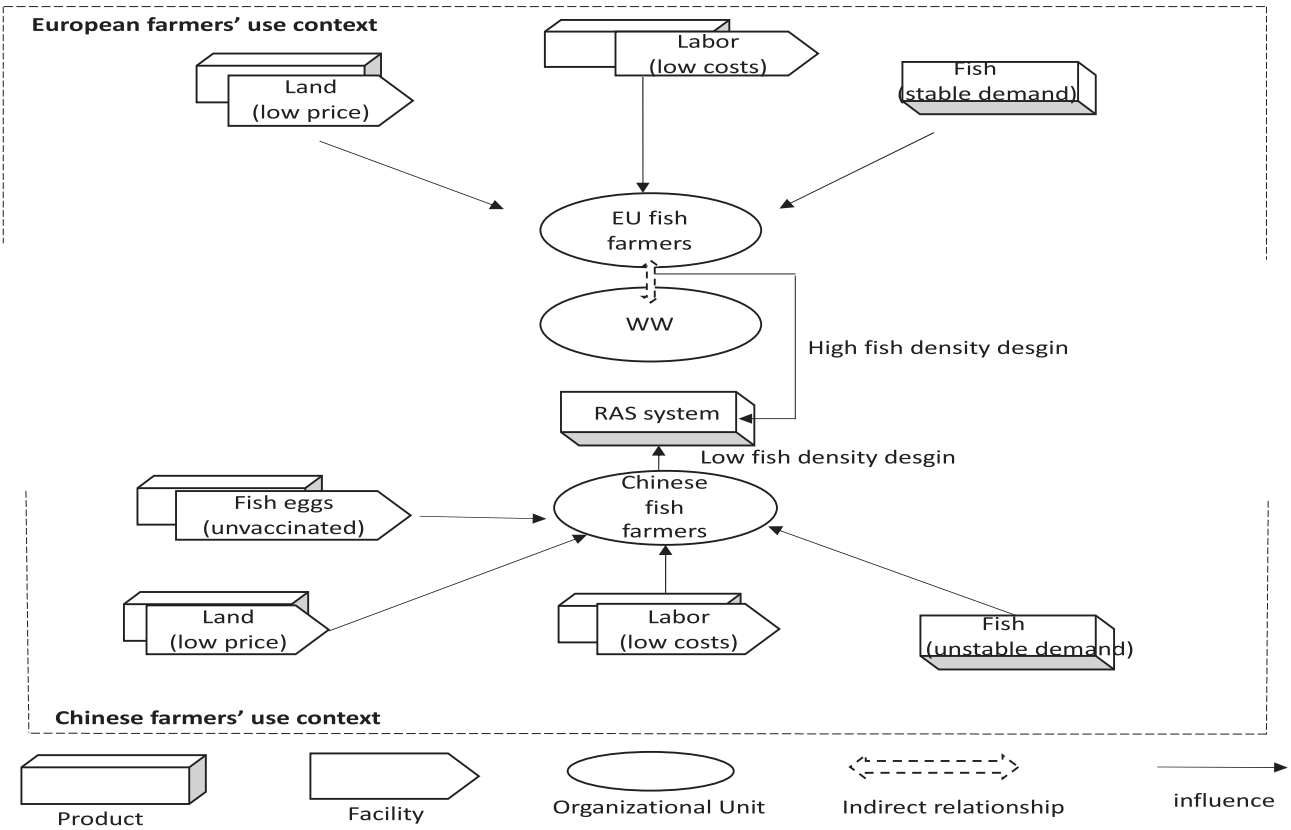

Fig. 2. Pattern of disputes over RAS design.

commented:

> *Fish disease is the biggest challenge for fish farmers in China. Bacteria could come from water, fish feed, and operation. In the foreign workshops, workers need to change clothes. Here, anyone can come into the workshop. They [foreign workshops] strictly control every step. Though we have an RAS system as they do, we do not learn other things from them. For example, we selected fish eggs without quality control due to cost considerations.*

The RAS solution was a replacement for the flowing-water system, which had been embedded in the use context for years and thus had well-functioning interfaces with Chinese fish farmers' other resources for raising fish, such as fish eggs, fish feed, and workshop protocols. Over time, these resources shaped each other's features through their interfaces (Håkansson & Waluszewski, 2002) to fit with each other and, ultimately, to enable farmers to create value. For example, the water in the flowing-water system with high levels of water exchange tolerated the poor quality of fish eggs and fish feed as well as loose workshop protocols without leading to fish deaths.

When the RAS solution was combined with the existing resources in the Chinese farmers' use context, various resource interfaces related to RAS water were generated and turned out to be unfit during use. The unfit aspects of the technical interfaces included the unhealthy fish eggs (i.e., facility) in the slowly exchanging RAS water (i.e., facility), which became easily contaminated, and the antibiotics (i.e., facility) added to the biologically maintained RAS water (i.e., facility), which destroyed the ecological balance in the RAS water and led to more fish (i.e., product) deaths. In the mixed interfaces, an instance of unfit was the poor workshop protocols in the farms (i.e., organizational unit) bringing bacteria into the RAS water with low rate of water exchange (i.e., facility), which led the fish (i.e., product) to become easily infected.

However, it was difficult for both WW and the farmers to foresee the series of unfit instances in these new resource interfaces linked to the solution output (RAS water) for two reasons. First, they had limited knowledge of others' resources involved in the interfaces; for example, WW had no idea of the quality of resources that were combined with the RAS water, and farmers were unaware that RAS water was maintained using biological methods. Second, some features of the solution output and its interacting resources became apparent to the actors only during solution utilization through its interactions with other resources (Håkansson & Waluszewski, 2002). For example, WW did not realize that the RAS system was a relatively closed water system with low levels of water exchange until the third failure (at HY) occurred. Furthermore, WW realized only later that the unvaccinated fish eggs had pre-existing diseases.

These factors prevent actors from appreciating all of the interfaces with the solution output. Hence, one challenge in co-creating solution value during the solution utilization phase is actors' limited knowledge of the resource interfaces related to the solution output in the solution use context. Based on this, we propose the following:

Proposition 1. *During solution utilization, various new resource interfaces related to solution output are generated. The resource interfaces manifest themselves during the solution utilization phase and are contingent on the customer's use context. Due to the newness of these resource interfaces, the fit between interacting resources is likely to be suboptimal, limiting solution value creation.*

To address this challenge, many companies in heavy and ICT industries today have institutionalized rigid regimes for testing prototypes and full solutions in the customer's context (e.g., Baraldi et al., 2011) in order to develop the knowledge of solution utilization in that context before full-scale implementation. Additionally, as actors often have only partial knowledge of the resource interfaces related to solution output, it is important to encourage knowledge sharing and joint exploration of these resource interfaces. Building organizational resource interfaces (e.g., interorganizational relationships) between actors (whose resources

are directly interacting with the solution output for solution value creation; Baraldi & Strömsten, 2006) creates a foundation for the actors to share openly and collaborate closely (Håkansson & Waluszewski, 2002).

5.2. Challenge two: Hidden resource imprints of standardized parts of the solution that are unsuitable for the solution use context

In addition to their functional goals (i.e., saving water and raising healthy fish), Chinese fish farmers also had an economic goal related to the RAS solution (i.e., reducing operational costs). However, the farmers found that the RAS solution consumed much more energy than the flowing-water system—in particular, deep fish pools in the RAS system increased energy costs and needed to be replaced with wide fish pools. Mr. Xu told us:

> *…but i feel they [WW] do not know why they dig deep [fish pools]. I do not think it is due to technical reasons. It is that they do not know our business in China.*

The general manager of HY also commented on the deep fish pools:

> *In Sweden, the land costs, the material costs, the human costs are higher than in China. So, in Sweden, they dig deep fish pools for high fish density per cubic meter. When they come to China, they should think about how to design a system most suitable for the Chinese economic situation.*

To achieve cost efficiency, solution providers standardize parts of the solution to reduce costs (e.g., design costs, production costs). In the case study, WW considered some parts of the RAS design used in Europe, such as the deep fish pools, as standard elements. These standard elements were incorporated into the RAS systems for their Chinese customers, as well. However, they did not realize that the deep fish pool part that they had deemed standardized was not developed in a vacuum but rather against a specific and distinct backdrop (Baraldi et al., 2012; Granovetter, 1992; Wedin, 2001) of the European fish farmers' context, in which the combined economic costs of land and labor entailed by a wide fish pool were higher than the costs of energy implied by a deep fish pool. Furthermore, stable and large market demand for fish in Europe also favored a deep fish pool design. As such, the deep fish pool design was a result of resource interactions, through which the resources (e.g., the land) influenced other features (e.g., fish pool; Baraldi & Strömsten, 2006, 2008; Jahre et al., 2006) via their direct and indirect interfaces in order to make them fit along technical, economic, and social dimensions (Håkansson & Waluszewski, 2002). Thus, the fish pool design in the RAS received "imprints" for satisfying the economic requirements of other resources (Baraldi et al., 2012) in order to better fit European fish farmers' resource networks.

However, over time, the imprints often come to be seen as an essential part of the solution rather than the consequences of resource embeddedness in a specific network context. Therefore, they are often overlooked by the actors when evaluating the fit between the solution and a specific customer's solution use context. Hence, another challenge for actors in co-creating solution value in solution utilization is identifying unsuitable hidden imprints of standardized parts of the solution for the customer's use context. This process can be uneasy, as illustrated by the following quotes. Mr. Xu said helplessly:

> *I am a farmer and received little education, but I have been in this field for so many years. Sweden did not listen to me. They think they are right, but I feel they do not know why they dig deep.*

The WW on-site manager for HY described the fish pool conflict:

> *In many areas, our thoughts conflict with the customer's thoughts. It is quite hard to communicate […] I can feel the customer has used the RAS for years and speaks from experience. They cannot accept our design ideas.*

The French fish expert was confused:

> *You know when you talk to farmers, ok, you want high density, you want to save water. Ok, i [will] make a system with high density and low water consumption.*

Building on the above, we propose the following:

Proposition 2. *The standardized elements of a solution receive imprints from the use context in which the standardization occurs. If the solution is used in another context, (e.g., another geography, industry, or culture), these imprints may start to hinder solution value creation.*

Hence, addressing this challenge requires actors to be open, clear, and cooperative in the co-identifying process. In most cases, it is the customer who will have to initiate this process by providing solid evidence of why some standardized parts of the solution are unsuitable for their use context. Only after this can the solution provider think critically about the possible imprints in the standardized parts and possible ways of customizing the solution to fit the current customer's use context.

5.3. Challenge three: Inconspicuous gradual changes in resources over time and their unclear implications for solution value creation

In resource interaction processes, the features of resources emerge and change as they interact with other resources in networks (Håkansson & Waluszewski, 2002). The fish farmer Mr. Xu described the fish death disaster as follows:

> *I raised sheta in the RAS. From sheta eggs to grown sheta fish ready for sell, [it] usually takes one year. [For] about three months, the fish grew in the RAS quite well. But then, some fish got sick all of a sudden, and more fish became sick quickly after that.*

The WW team analyzed the failures of the three projects. WW's fish expert commented:

> *We asked ourselves why fish always got sick [at] around three months in our systems. The possible explanation [for] this is that when the fish grow bigger in our system, they each will have less and less space in the system. This causes more and more stress to the fish, [which is] hard to notice for the farmers. Finally, it induces the pre-existing diseases within the unvaccinated fish to emerge after three months. The diseases spread very quickly in the RAS water, which is a "relatively closed" system.*

As shown, after the failures of the three projects, WW realized in hindsight the importance of gradual changes in the resources that resulted from resource interactions: As the fish grew bigger in the RAS, the living space for each fish was continuously reduced, which resulted in growing stress for the fish. In the absence of fish vaccines, the pre-existing diseases emerged after three months and, in turn, spread rapidly from one fish to another in the relatively closed RAS. This indicates that the gradual changes in the resources caused by the resource interaction processes (e.g., the RAS water, fish feed, fish eggs) could decrease the fit between the resources (e.g., grown infected fish and the RAS water with low rate of water exchange) and consequently lead to solution value creation failure.

Due to the characteristics of solutions (e.g., high value creation, high customization level), customers tend to use solutions for prolonged periods of time (Tuli et al., 2007). Therefore, it is unavoidable that some resources will change as a result of resource interactions over time (Håkansson & Waluszewski, 2002). Such changes take two main forms. First, actors (i.e., organizational units) may identify a need for a change in their resources (e.g., Skarp & Gadde, 2008) and make the necessary modifications to their resources to achieve a better fit between resources for solution value creation. Second, resources may change more spontaneously as a result of ongoing resource interaction processes (Håkansson & Waluszewski, 2002). Especially in the latter case, it is very difficult for actors to observe gradual changes (e.g., fish slowly becoming unwell while growing in the RAS water) and evaluate the

implications of the changes (e.g., reduced living space for the growing fish in the RAS) for solution value creation because (1) the spontaneous changes in the resources occur without the active involvement of the actors and (2) the changes may unfold slowly. Hence, we posit the following:

Proposition 3. *Resources, which underlie solution value creation, may change spontaneously due to ongoing resource interactions over time. Such spontaneous changes in resources are often gradual, which makes it difficult to detect them and assess their potential impacts on solution value creation.*

To address this challenge, it is important for the solution provider and customer to be aware that barely discernible changes in the solution itself and the resources interacting with the solution are likely to occur over time during solution utilization. A possible way to address this is to leverage digital technologies to track the real-time status of the solution and the interacting resources to detect the gradual changes. The data collected on the resources can then be used to establish models to assess the possible impacts of the gradual changes on the resources in the long run (Elia et al., 2020). Discussions among actors with expertise in the resources that are undergoing gradual changes and have direct resource interfaces with the changing resources would also be helpful in evaluating the implications of the changes for solution value creation.

5.4. Overarching challenge: Actors' inability to access knowledge required for successful resourcification of the solution and its outputs developed over time and in different use contexts.

The common denominator in all previous three challenges is actors' lack of knowledge with regard to utilizing the solution and its outputs as facilities for solution value creation—in particular, not knowing enough about (1) solution outputs' resource interfaces, (2) the resource imprints of standardized elements, and (3) gradual changes in resources and their implications. When applying the RIA perspective, knowledge has a dual role in relation to resources. First, both physical and social resources contain a knowledge dimension (Bocconcelli et al., 2020). In the context of solutions—defined as customized product–service combinations that render a specific output relevant to their business customers—knowledge is a resource embedded in a solution (which is itself a "product" resource type before use). The standardized elements of the solution (e.g., the design of the RAS) embed knowledge generated through actors' interactions in specific solution use contexts in the past (e.g., the European farmers' context). Thus, the standardized elements do not have the capacity to change over time to adjust to the changes in customers' use and use contexts. The customized elements of the solution, on the other hand, reflect the knowledge that is constantly obtained through actors' interactions in the present customer's use context (e.g., a modified RAS design that considers the availability of geothermal energy in Tianjin). Thus, the customized elements have the capacity to change over time to adjust to the changes in the customer's use and use context, but these changes are ongoing rather than periodic in nature.

Second, knowledge is a prerequisite for resourcification: the social process by which things become resources (Håkansson & Snehota, 1995; Hultman et al., 2021). Hultman et al. (2021, p. 2) highlight that the resourcification process is always temporally, spatially, and socially distributed: it "carries elements of past resourcification, occurs in the present, and is a gamble on future profit and wealth" and "occurs in multiple somewhere[s]." In the context of solution business, a social process of resourcification occurs whenever the solution is put into use—namely, the solution as a product resource transitions into a facility resource. The success of this resourcification process is contingent on the actors' collective ability to bridge the inherent temporal, spatial, and social gaps in this process. For example, the RAS fish pool design was originally developed in Europe based on the needs of European fish farmers. This fish pool design was later—and ultimately unsuccessfully—adopted by three Chinese fish farmers (privately owned MF, privately owned Xu, and public–private HY), despite extensive modification efforts by WW. Thus, it can be argued that the successful resourcification of the RAS fish pool design never occurred in China due to the involved actors' inability to bridge the temporal, spatial, and social gaps in the resourcification process.

Hultman et al. (2021) also put forward conditions for successful resourcification. In the solution business context, two conditions are particularly relevant: (1) the ability to mobilize different forms of knowledge (why, how-to, where, by-whom, for-whom) and (2) the presence of supportive discourses. Combining the identified knowledge gaps in utilizing the solution and its outputs as facilities for solution value creation (expressed in Propositions 1–3) and the conditions for successful resourcification (Hultman et al., 2021), we suggest three ways of bridging the temporal, spatial, and social gaps in the resourcification process of solutions. First, the documentation related to the standardized solution elements should capture the contextual where, by-whom, for-whom, and why knowledge in addition to the how-to knowledge. Making visible these different forms of knowledge that are embedded in the standardized solution elements enables all relevant network actors to identify the possible areas of "unfit" early in the solution development process (e.g., in relation to customers' operational processes and resources of other suppliers). In our case, the resourcification of the RAS solution and its output (i.e., RAS water) was supported by the how-to knowledge (e.g., deep fish pool design), but the for-whom knowledge (i.e., European fish farmers) and why knowledge (i.e., high land and labor costs, stable and high market demand) were left implicit. Second, the solution development phase should be designed to include ample opportunities for the customer and other network actors to express their current context in terms of why, how-to, where, and for-whom knowledge. In this way, the solution provider can better assess the optimality of the solution's standardization–customization balance and adapt the customized solution elements based on all relevant information. Third, the solution utilization phase should foster ongoing and robust debate among the solution provider, the customer, and other relevant network actors. Such ongoing discussion is necessary to learn about the new resource interfaces related to solution outputs as well as gradual changes in all relevant resources over time. This constantly developed knowledge can be used to further customize the solution to make it more and more compatible with other resources in that use context (as the farmer Mr. Xu did), thereby contributing to solution value creation.

6. Conclusions

In this study, we investigated the challenges that customers experience when utilizing a new solution that interacts with other resources in their use context. To achieve this, we employed a RIA to analyze the challenges related to solution value co-creation during the solution utilization phase. Based on an in-depth case study of three failed projects by a Swedish clean-tech company, we found three challenges for co-creating solution value during solution utilization: (1) new resource interfaces related to solution output that manifest themselves in use and in a specific context, (2) hidden resource imprints of standardized parts of the solution that are unsuitable for the solution use context, and (3) inconspicuous gradual changes in resources over time and their unclear implications for solution value creation. These three challenges led us to identify an overarching challenge of co-creating solution value in solution utilization: actors' inability to access the knowledge required for successful resourcification of the solution and its outputs developed over time and in different contexts. Based on these findings, we put forward three propositions that can be tested and further developed in future studies.

We make four main contributions to the solution business literature. First, to our knowledge, this is the first empirical study that has investigated challenges during the solution utilization phase from the network perspective. Furthermore, there is scant existing research focusing on the solution utilization phase (Macdonald et al., 2016) or illuminating the customer (Macdonald et al., 2016; Petri & Jacob, 2016)

or network perspective (Storbacka et al., 2013). Second, Propositions 1 and 3 improve our understanding of the dynamics related to solution value creation. Prior research has established that exact manifestations of solutions are difficult to predict (Cantù et al., 2012). We build on this and show that, in addition to solution outcomes—and hence solution value creation—being difficult to predict, the related changes in resources and resource interfaces are difficult to detect, and their impacts are difficult to assess. Thus, the dynamics of solution value creation pose a threefold managerial challenge: detection, impact assessment, and prediction. Third, Propositions 1 and 2 provide a more nuanced conceptualization of networked solutions. Prior research has recognized the networked, interactive, and relational nature of solutions (e.g., Cantù et al., 2012; Skarp & Gadde, 2008; Storbacka et al., 2013). However, merely knowing that a phenomenon is interactive or relational provides limited guidance on how to manage it. The concepts of resource interfaces and imprints have the potential to advance our theorizing about solutions and solution business transformation. Finally, Proposition 2 and the discussion of the resourcification of solutions introduce novel perspectives to the established discussion on the standardization–customization balance of solutions (Johansson et al., 2003; Sawhney, 2006; Tuli et al., 2007). Perhaps due to the always-present customization of solutions, the extant solution literature has paid very little attention to the context of solution business. According to our knowledge, only two studies have explicitly investigated how solutions vary from one context to another (Kleinaltenkamp et al., 2021; Storbacka et al., 2013). Our findings suggest that an intimate appreciation of the relevant contexts—both the context that has given the standardized elements its imprints and the customer's use context—is crucial for successful solution business.

Furthermore, we make two contributions to the RIA literature. First, we answer Baraldi et al.'s (2012) call for research conceptualizing "knowledge" in RIA. In addition to knowledge constituting important parts of organizational units and interorganizational relationships, it is also embedded in the solution itself as a product. Echoing Normann (2001), standardized solution elements are, in essence, "frozen knowledge," reflecting historical interactions, and customized elements, reflecting current interactions. Making this frozen knowledge of products visible is likely to make RIA-informed theorizing about knowledge more explicit and precise. Second, we provide a more nuanced perspective on the process of resourcification in the context of solutions. RIA scholars have made considerable advances in conceptualizing resources (e.g., Håkansson et al., 2009) and illuminating their interactions (e.g., Baraldi et al., 2012; Bocconcelli et al., 2020). Therefore, the influential 4R model has thus far mainly been used as a categorization device to classify resources and analyze their interactions. However, the process of resources becoming resources—or changing from one type of resource to another—has been given less attention. We draw on the concept of resourcification (Hultman et al., 2021) and show that specific knowledge gaps must be bridged under favorable conditions for a resource to transform from one type (e.g., product) to another (e.g., facility). Thus, the notion of resourcification draws our attention to the possibility of extending the 4R model to examine the transformations of resources over time.

Our study has three main implications for managerial practices. First, it is important for the solution provider and the customer to be aware that barely discernible changes in the solution itself or the resources interacting with the solution are likely to occur in the process of solution utilization. This may later cause unfit between the solution and the resources in the network, leading to solution value creation failure. A possible way to address this is to leverage digital technologies to track and analyze the real-time status of the solution and the interacting resources to detect potential changes for further assessment. Second, our case shows that ensuring the quality of solution output alone does not guarantee solution value creation for the customers in their use contexts. Therefore, providers need to go one step further to support their customers' use of the solution output—for example, shaping the output to adapt to all relevant resources interacting with the solution output in the customer's use context along technical, social, and economic dimensions. The customers and other relevant actors in the network (e.g., whose resources are interacting with the solution) need to work collaboratively with the provider to continuously manage the resource interfaces by openly sharing knowledge of their resources. Third, the standardized items in a solution are also developed to fit a specific context, which is often inadvertently overlooked by the provider. Hence, when the solution is used in a different context (e.g., another geography, industry, or culture), it is important for the provider to work closely with the customer and other relevant actors in the network to identify the potentially problematic standardized items that may generate unfit in the customer's use context.

As with all studies, ours is not without its limitations. However, we hope that the limitations of this study can be used as starting points for further research. First, our findings are based on a single case study on one solution provider's failed projects. Hence, more empirical research on this theme is encouraged in other industrial and geographical contexts, as well as drawing on successful projects. Second, in-depth case studies are explorative in nature, and thus future studies using alternative research methods are needed. In particular, fuzzy-set qualitative comparative analysis could be a powerful technique for illuminating further details in the contextual dynamics of solution value creation. Third, in the present study, we aimed to investigate the entire relevant network; hence, our findings remain at a relatively high level. Therefore, further research is needed to investigate the particular challenges of different actors in the network (e.g., solution provider, provider's providers, customer, customer's customers, regulator) in more detail.

CRediT authorship contribution statement

Lei Huang: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Suvi Nenonen:** Supervision, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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