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Introduction

B2B relationship management in complex product systems (CoPS)

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ABSTRACT

The management of complex product systems (CoPS) has been studied in the academic literature, so far, from a process, organizational, external environment, and technological perspective. Little research has investigated stakeholders' perspectives, particularly when the management of innovative customized solutions is involved. When firms are engaging more and more in complex projects, to create a competitive advantage, academic research should focus on stakeholder interactions and the detailed processes they use, to reinforce stakeholder engagement and to co-create value. Hence, this call for paper was an invitation for scholars to submit papers to study CoPS from a relationship management perspective.

1. Introduction

Complex product systems (CoPS) are high-value, high-technology, and engineering-intensive products (e.g., aircraft, high-speed trains), systems (e.g., telecom networks), services (large ERP, software projects), and constructs (airports, intelligent buildings). Acha, Davies, Hobday, and Salter (2004) relate the word “complex” to the number of customized components and the knowledge skills required in producing them. The underlying economic patterns in project-based complex products are markedly different from those regulating mass-market commodity goods (Woodward, 1958). Scholars in innovation have also advanced the differentiation between mass-produced consumer goods and project-based, low-volume, high-technology, high-value capital goods (Kiamehr, Hobday, & Hamedi, 2015). Because of their inherent complexity, CoPS may emerge from complex search behaviors (Appio, Martini, Messeni Petruzzelli, Neirotti, & Van Looy, 2017; Martini, Neirotti, & Appio, 2017) and the combinatorial activities of knowledge bases (Gruber, Harhoff, & Hoisl, 2013) spanning different industries and disciplinary domains. Most often, such knowledge recombination leads to CoPS that, being radical in nature, may replace well-established systems and open new markets (O'Malley, O'Dwyer, McNally, & Murphy, 2014). They are business-to-business (BtoB) customized goods, which are the backbone of our modern economy (Hobday, Rush, & Tidd, 2000).

A number of CoPS definitions exist (Ranjbar, 2018.) In the most widely adopted definitions, CoPS is assimilated with complex capital goods (Rosenberg, 1982; Chudnovsky et al., 1983) and complex systems (Miller, Hobday, Lerouxdemers, & Olleros, 1995). However, it was Hobday (1998), as a pioneer of research on CoPS, who defined CoPS as any high-cost, engineering-intensive product (e.g., aircrafts, high-speed trains), system (e.g., large ERP, software projects), network (e.g., telecom network), and construct (e.g., airports, intelligent buildings). Hobday and Davies (2005) provided conceptual frameworks to analyze the innovation dynamics and strategic and organizational insights of CoPS. Their definition and frameworks prevail in the literature.

Extant CoPS literature discusses a wide range of examples, such as flight simulators (Miller et al., 1995), cellular mobile communication systems (Davies, 1997), complex software (Hobday & Brady, 2000), aircraft engine control systems (Prencipe, 2000), telecommunication networks and systems (Choung & Hwang, 2007; Park, 2013), e-government systems (Park & Kim, 2014), military and commercial aircrafts (Lee & Yoon, 2015; Naghizadeh, Manteghi, Ranga, & Naghizadeh, 2017), stored program control switches (Zhang & Igel, 2001), nuclear industry (Wu, Ye, Ding, Lu, & Euwema, 2017), gas turbines (Majidpour, 2016), and power-generation systems (Kiamehr, 2017). However, six industrial areas are frequently investigated through qualitative research in CoPS studies: information technology, telecommunication systems and equipment, aerospace, energy, complex construction projects, and machinery and equipment (Ranjbar, 2018). Overall, the literature clearly demarcates the domain of CoPS from the domain of low-technology capital goods, mass-market commodity goods, etc. (Hobday et al., 2000; Ren & Yeo, 2006) and mainly focuses on the areas of process, organization, external environment, and technology.

The business area has not, so far, been the focus of much attention, and a search for articles specifically analyzing CoPS through a marketing lens shows that they remain scarce, compared to the literature on their technological development (Brady, Davies, & Gann, 2005; Davies, Brady, & Hobday, 2007; Liinamaa et al., 2016; Winkelbach & Walter, 2015). The link between the management of business relationships and the idiosyncratic nature of CoPS has not yet been fully investigated in industrial marketing literature.

One major stream of literature in BtoB marketing comes from the Industrial Marketing and Purchasing Group (IMP Group), who first defined the dyadic relationship between firms as “of paramount interest” (Anderson et al., 1994, p 13), based on the seminal book from the IMP Group (1982) and a proposed model of interaction that connects customer/supplier firms through the lens of the environment and the atmosphere of relationships. In the same 1994 article (Anderson et al., researchers highlight that greater attention should be directed toward studying the business networks into which those dyadic relationships are embedded. Since then, the IMP Group has taken business networks as their level of business relationship analysis, focusing

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on a holistic vision of such relationships, in which the nature of the product is present, but not prevailing.

We need to turn to the academic literature on purchasing to find how the product portfolio is perceived, through its influence on the nature of the relationship: from the Kraljic (1983), which sets the foundation for product segmentation in the purchasing process, to Bensaou (1999), who connected product segmentation to supplier–customer relationship management. Since then, many scholars in purchasing refer to those seminal articles to study purchasing relationship management strategies (Caniels & Gelderman, 2005; Caniëls & Gelderman, 2007; Hesping & Schiele, 2015, 2016).

In a 2002 article, Dubois and Petersen compare the portfolio model with the industrial network model and observe that they convey two very different approaches that are difficult to mix together. They recognize that the business network lens leads to a more rich and complex analysis of firm interactions.

Still, researchers find it difficult to follow Dubois and Petersen's recommendations to consider products as a “network entity” rather than a “given” entity. This conceptual hurdle—the difficulty in linking product segmentation to the industrial network theory—may explain why, when it comes to complex projects, some researchers from the IMP Group have used another stream of research specific to this type of complex products and services, referring to project marketing and the marketing of solutions (see IMM, 2007, special issue).

Scholars in industrial marketing do refer to such complex products, but they tend to do it within a panel of other products (Lacoste, 2016) or to analyze marketing trends that are not specific to CoPS, such as servitization (Kapletia & Probert, 2010; Raddats, Baines, Burton, Story, & Zolkiewski, 2016; Raddats & Easingwood, 2010). In addition, due to the high entry barriers of CoPS, many latecomer firms in the past have shown their intrinsic weaknesses in technology. However, through the international technology transfer and technological alliances, these latecomer firms (e.g., China's high-speed rail) have shown significant progress in their technology (Lee & Yoon, 2015). As a result, the global competition in CoPs—from business and marketing perspectives—has become more intense than ever among the incumbent and latecomer firms. New marketing or selling perspectives and theoretical frameworks are thus called for in investigating CoPS.

As of today, although CoPS refers to B2B customized goods, other streams of literature, such as innovation and strategy, have mostly investigated this topic.

2. Extant literature on CoPS

The main research areas investigated so far (Ranjbar, 2018; Ren & Yeo, 2006) deal with the following topics.

First, *CoPS characteristics,* such as the innovative parameters (Hobday, 1998); difficulties firms cope with when developing CoPS (Hansen and Rush, 1998; Hobday & Rush, 1999); product volume, life cycle, degree of technological novelty, and customization; breadth and depth of knowledge, skills, coordination efforts, and regulatory-party-involvement efforts (Ren & Yeo, 2006). Dedehayir, Nokelainen, and Mäkinen (2014) argue that when disruptive innovation occurs in the context of CoPS, it has different characteristics than it does in the context of commodity products. For instance, disruptions in CoPS are not nurtured in low-end niche markets; they initially satisfy mainstream-market performance demand, and they have a higher unit price than the incumbent technology. Using an in-depth case study of a large European project, França (2018) investigated the interaction and coordination efforts undertaken by multiple and diverse partners during the life cycle of a CoPS. He found that in cases of CoPS, coordination mechanisms to develop common understanding and business alignment in a multi-party configuration require adaptation in each stage of the life cycle and a wise implementation of iterative learning processes.

Second, *key capabilities and competencies* to produce CoPS, such as project management, network management, market capabilities, system integration activities (Hardstone, 2004), core capabilities concerning system integration, complex supply chain management, logistics management, risk management, knowledge management, leadership styles, political skills, and legal expertise (Ren & Yeo, 2006). Moody and Dodgson (2006) examined the characteristics of complex collaborative project in which international firms and agencies interacted to develop a new satellite. They identified a number of factors that contributed to the success of the initiative, namely, the evolution of the organizational structures of the firms involved, the use of a wide range of innovation-management tools, and the use of a unifying development methodology. In the same vein, Ngai, Jin, and Liang (2008) tried to determine whether an inter-organizational knowledge-management approach could support the development of CoPS. Authors in this stream also emphasized the presence of dynamic capabilities—such as a customer-oriented perspective controlling a multi-organization network—and absorptive capacity on organizational learning (Su & Liu, 2012). For instance, by investigating two companies—a medical device manufacturer and an aircraft manufacturer—Abrell, Benker, and Pihlajamaa (2018) elaborated an absorptive capacity-based model made out of three capabilities—recognition of the value, acquisition, and assimilation/transformation of user knowledge—with the aim of integrating users' knowledge into innovation processes in the context of CoPS. Baraldi (2009) performed a study of a furniture manufacturer, in which they showed how user-related complexity dimensions can be included in the process of implementing an ERP system. The complexity dimensions include the importance of the capital good for the user; the user's perception of its complexity and the strength and complexity of the routines to be changed at the using organization; the degree of change from previous solutions replaced by the implemented CoPS; and the complexity of learning routines. By focusing on the phases of the fuzzy front end of the product innovation process, Liu and Su (2014) explore the role of market orientation and technology orientation in the R&D of CoPS, showing that market orientation has an effect on both low-tech and high-tech CoPS innovation success, whereas technology orientation has an impact only on high-tech CoPS success.

Another aspect of CoPS literature consistently focuses on *managerial methods and tools* (Ranjbar, 2018). According to Hobday and Rush (1999), some managerial tools are still unproven, and IT tools are not effective and do not have a good fit with practice. This has stimulated research aimed at developing new tools and methods, such as a fast method for the analysis and improvement of software-intensive CoPS (Hobday & Brady, 2000); a project safeguard, as a way to embed a real option in CoPS (Gil, 2007); a multilevel framework for the risk-management capability maturity model (Yeo & Ren, 2009); a maturity-focused method for scheduling, monitoring, and evaluating a system (Magnaye, Sauser, Patanakul, Nowicki, & Randall, 2014); a new method of supplier selection for CoPS projects (Du, Guo, Huang, Li, & Guo, 2015); an SECI model (socialization-externalization-combination-internalization) studying the knowledge-creation mechanism and the relationship between knowledge-creation models and innovation performance during CoPS (Li, Wang, Zhong, & Zou, 2018), in cases of explicit, grey, and tacit knowledge; and the development of more-sophisticated models, such as a novel hybrid approach using ant-colony optimization and Shapley value, aimed at production-planning conflict resolutions (Du & Guo, 2016); a weighted LeaderRank algorithm and susceptible-infected-recovered (SIR) model of weighted and directed complex networks (WDCNs), employed to identify the influential function modules of modular CoPS at the conceptual design stage (Li, Chu, Chu, & Liu, 2014; Li, Liu, & Zhou, 2018); a set of indicators based on fuzzy quality function deployment (QFD); and failure mode and effects analysis (FMEA) for the redesign of specific CoPS components (Ma, Chu, Xue, & Chen, 2016).

Some scholars have pointed out the *organizational structure* in project-based organizations as the most widely adopted structure (Davies, Brady, Prencipe, & Hobday, 2011; Gann & Salter, 2000). A project-based organization seems to be better-equipped to cope with changing

customer needs and emerging design characteristics; however, some problems persist, such as poor capability to reach economies of scale and scope, manage discontinuities in knowledge flows, establish long-term client relations, develop effective systems-integration capability, connect project-based learning, and the company's business processes (Davies et al., 2011). Oshri and Newell (2005) focus on multi-project management approaches, allowing companies to share CoPS components and platforms, arguing that what facilitates these sharing dynamics are the coordination, communication, and knowledge transfer mechanisms across projects, along with an organizational form that centralizes some development activities.

Finally, four minor streams emerge. First, *catch up by latecomers*, both at the national level—with countries like China, South Korea, Brazil, India, and Iran (Binz, Gosens, Hansen, & Hansen, 2017; Chen, Liu, & Hu, 2016; Choung & Hwang, 2007; Lee & Yoon, 2015; Park, 2013)—and at the firm level, paying attention to the firm's strategies and specific market and technological regimes (Kiamehr, 2017; Kiamehr et al., 2015; Majidpour, 2016). Second, the *government role and policies* (Davies & Brady, 1998; Hobday et al., 2000; Kiamehr et al., 2015; Kiamehr, Hobday, & Kermanshah, 2014; Ren & Yeo, 2006) aimed at prioritizing investments, promoting educational programs to develop the necessary knowledge and skills, and supervising and enacting proper legislation. Third, the assessment of the *economic performance* of CoPS, in which only Acha et al. (2004) introduce a new industrial classification system for CoPS, with specific quantitative indicators. Fourth, factors enabling *operations in CoPS,* such as R&D capabilities, the creation of effective collaborative networks, the capability to get governmental support, and the establishment of a demand base (Park & Ji, 2015).

Hence, extant CoPS academic literature focuses mainly on government roles and policies, the economic performance of CoPS, and catch-up dynamics by latecomers—at industry and national levels. However, the literature emphasizes managerial methods and tools, key capabilities, and organizational structure when the level of analysis is on the firm, with CoPS characteristics to bridge the two (Ranjbar, 2018). It has emerged that, at the firm level, this area has not, so far, focused much attention on the analysis of CoPS through a marketing lens (Brady et al., 2005; Davies et al., 2007; Liinamaa et al., 2016; Winkelbach & Walter, 2015).

To advance our knowledge and theoretical understanding, and to shed further light on empirical examination and managerial applications, this special issue invited scholars to submit their best work that addresses CoPS, bridging a gap between innovation, organizational literature, and marketing. We invited papers that examine novel phenomena and offer interesting empirical insights and theoretical contributions related to B2B relationship management in CoPS. Having CoPS at core of the research, possible topics could have included vertical or horizontal relationship management, ICT platforms and tools for collaborative management, dynamic stakeholder networks, marketing and selling—compared to other products and services—procurement and sales processes, exporting strategies of firms, knowledge-search practices and recombinations, and co-creation and co-development strategies.

3. Overview of the contributions

The papers presented in this special issue advance our understanding of different relational perspectives in inter-organizational interactions, in a CoPS setting.

Lehtinen et al. (2018) investigate the role of stakeholder engagement in the context of CoPS. They contribute to existing research by disentangling both stakeholder engagement—and disengagement—from decision-making and value-creation activities, over time. The driving research question asks how and why internal stakeholders engage—and disengage—external stakeholders, over time, in a complex product system. Through a qualitative and inductive research approach, enriched by primary and secondary data, the authors relied on the stakeholder theory to address the research question. The selected case study concerned a district-development megaproject located in Europe, inside a metropolitan area. Megaprojects are peculiar cases of CoPS, as they contain physical constructs, intangible services, and high-tech solutions running in a highly dynamic, multi-actor environment. The aim of the megaproject was to demolish an entire district center and rebuild a commercial shopping center and residential buildings, with multiple modern transportation facilities, while at the same time preserving and conveying the traditional and cultural heritage of the area. It was started in 2004, and it will last until 2020, with a total development cost of EUR 3.4 billion. The contribution this research makes lies in the identification of different practices to dynamically couple—or uncouple—stakeholders. Three major findings emerge: first, the crucial role of the timely disengagement of external stakeholders in governing CoPS; second, four novel rationales (framing, legitimating, maintaining, and expanding) highlight the importance of the lifecycle perspective in CoPS, in which temporal ordering is key to understanding when and how to engage and disengage stakeholders; and third, new causal logics and conceptual relationships become instrumental in improving our knowledge of stakeholder management in CoPS.

Crespin-Mazet et al. (2018) investigate the relational dynamic and interaction processes enabling CoPS suppliers to integrate the diversity and complexity of customers' stakes (technical, economic, social, and political) in their innovation process. In a longitudinal case study of the contrasting approaches to marketing and sales processes of two suppliers involved in the construction of a tramway in a medium-sized city, they analyze the two suppliers' interactions with their main customer stakeholders and the co-development of innovation. They propose an integrated model of the marketing and sales processes, to support the co-development of CoPS innovation.

As the extant literature on CoPS recognizes the role of innovation in the creation of innovative modules leading to customized offerings but offers little insight into the relational processes between suppliers and customers to build such offerings and co-create value, Crespin-Mazet et al. (2018) integrate their findings into two other streams of research to build their integrated model. Beyond using the CoPS literature on innovation through modularity, they refer to the solution literature based on S/D logic (Vargo & Lusch, 2004) and on project marketing literature.

By linking the three streams of literature to their findings, they enrich the CoPS literature with the marketing and sales dimension that has been missing, so far, to investigate supplier–customer interactions to co-develop innovation and, hence, to co-create value all along the different project stages of CoPS activities.

Roehrich et al. (2018) also attempt to improve our knowledge of the management of innovation in an inter-organizational relationship, in a CoPS setting. The authors address the research question of how different organizational structures change over time to support the process of management innovation in an inter-organizational relationship, in a CoPS setting.

They differ from the Crespin-Mazet (2018) approach by not focusing on customer–supplier relationships but by focusing on the relationship between a technical consultancy firm and their customers and highlighting the knowledge-intensive interface within CoPS activities and the derived integrated project team that is created to manage innovation. Their research is supported by the knowledge-based approach and the literature on organizational design. From their literature review, they highlight that integrated project teams (IPT) may play a key role in a CoPS setting, as they may be the driver for collaborative and innovative inter-organizational relationships. To further investigate innovation management and the role of IPTs, they use a longitudinal study focusing on the dyadic relationship, over five years, between a consultancy firm and a water firm. Through this qualitative study, they unveil the detailed process of the management of innovation through

an IPT, in a CoPS setting. Their research shows how structures of collaboration, such as IPTs, spur innovation in inter-organizational relationships.

4. Conclusions and future research

All studies contribute to a better understanding of B2B relationships in a CoPS setting. They are complementary to each other by studying different actor relationships within a CoPS setting. Lehtinen et al. (2018) study stakeholders and the specific concept of engagement/disengagement. Crespin-Mazet et al. (2018) and Roehrich et al. (2018) contribute to a better understanding of the process of dyadic relationships in a CoPS setting in co-creating value. All research uses qualitative studies, which help to understand, in detail, the relational processes and stages of complex interactions. However, the described processes and practices could be slightly different in other contexts than the ones studied. Despite the invaluable contribution provided by these qualitative studies, we also envisage the adoption of quantitative methods, such as network analyses (Braha & Bar-Yam, 2007), patent-based indicators (Huenteler, Ossenbrink, Schmidt, & Hoffmann, 2016), and simulation techniques (Li, Li, Shen, Bi, & Sun, 2015; Saravi et al., 2018), among others.

All in all, as both Crespin-Mazet et al. (2018) and Roehrich et al. (2018) stress, before this call for papers, little research has studied dyadic interactions in managing CoPS, to co-create value, and, at this point, we know little of the project stakeholders' processes to manage innovative projects. Those first studies should be considered as a basis on which to develop further research and to create a CoPS interaction model that would move beyond the idiosyncratic features of specific case studies.

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