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RESEARCH PAPER

Modeling Simultaneous Cooperation and Competition Among Enterprises

Vik Pant · Eric Yu

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Abstract Coopetition (simultaneous cooperation and competition) between organizations has emerged as a prominent and critical industrial practice that allows organizations to increase combined welfare through cooperation while maximizing individual gains through competition. The formulation and enactment of such an organizational strategy entails designing and operating information systems that maximize benefits while minimizing costs from concomitant cooperation and competition. Coopetition raises new concerns and considerations about the design of data, processes, and interfaces of information systems. Analyzing coopetition can be challenging since cooperation and competition are paradoxical social behaviors that are undergirded by contradictory logics, hypotheses, and assumptions. Therefore, the ability of decision-makers to represent and reason about coopetition in a structured and systematic manner can be beneficial as it can support their efforts to co-design organizational strategies and information systems. This paper presents insights about the initial stages of an exploratory research project that is focused on the development of a modeling framework to support representation and reasoning of interorganizational coopetitive strategies. The objectives of this paper are to outline the goals of this research project which include: (1) identifying the primary characteristics for modeling and analyzing coopetitive relationships, as well as (2) proposing artefacts for expressing and evaluating these relationships.

Keywords Coopetition · Information system design · Enterprise modeling · Strategic analysis · Literature review

1 Introduction

Coopetition, which refers to simultaneous cooperation and competition, serves as “an important domain for industrial practice” (Bouncken et al. 2015). Sun and Xu (2005) assert that it characterizes “the current trend of economic activities”. It has become “increasingly popular in recent years” (Gnyawali and Park 2009) and is “an integral part of many companies’ daily agenda” (Bengtsson and Kock 2014). It refers to a phenomenon in which two or more enterprises cooperate and compete with each other simultaneously (Brandenburger and Nalebuff 1996). For example, coopetition is common in the software industry where vendors compete to sell products and services while cooperating in standards bodies, open source communities, and trade associations. Coopetition is also common within enterprises, such as multinational corporations, where local divisions cooperate to achieve objectives of their parent corporation while competing for resources that are offered by that corporate parent.

A multi-level example of coopetition is found in the transportation industry and concerns the relationships between airlines and their networks. Chiambaretto and Dumez (2016) note that simultaneous cooperation and competition takes place directly between airlines as well as indirectly through the alliances of which they are members.

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V. Pant (✉) · E. Yu
Faculty of Information, University of Toronto, Toronto, Canada
e-mail: vik.pant@mail.utoronto.ca

E. Yu
e-mail: eric.yu@utoronto.ca

E. Yu
Department of Computer Science, University of Toronto, Toronto, Canada

For example, many airlines compete to sell tickets on common routes to passengers but cooperate by sharing their airport facilities such as common check-in counters and lounges for passengers. Similarly, many airlines cooperate through interlining agreements whereby each partner airline advertises the routes and destinations of its partners as its own. However, some of these airlines also compete since they are members of different alliances (e.g., Star Aliance, SkyTeam, and One World) that offer competing loyalty programs.

Coopetition is a relevant topic of study in the information system (IS) engineering domain because researchers have "underscored the impact of corporate strategy on IT design" (Duh et al. 2006). Specifically, coopetition is relevant for information systems (IS) engineering because it imposes specific design considerations for systems that are used by partners who are also competitors. For example, adoption of coopetition as a strategy is likely to impact IS decisions about transaction processing, data sharing, compliance monitoring, and process integration within coopeting organizations.

The rest of the paper presents insights from the initial stages of an exploratory research project that is focused on the development of a modeling framework for analyzing interorganizational coopetition. This research project will adopt Design Science Research (DSR) as it offers an appropriate paradigm for studying socio-technical phenomena (Hevner et al. 2008; Peffers et al. 2007). DSR focuses on constructs, models, methods, and instantiations to portray and ponder IS in their environments. In this research project, DSR will be complemented by case studies because they accommodate the consideration of human interpretations (Walsham 1995) of socio-technical phenomena. This paper shares artefacts that were developed in the preliminary stages of this research project on the modeling of interorganizational coopetition.

In Sect. 2, we briefly give an outline of scholarly literature on the alignment of IS/IT strategy with organizational strategy. This discussion situates enterprise modeling (EM) research into coopetition within the IS engineering domain. In this section, we also present a synopsis about the evolution of coopetition theory within strategic management (SM) literature. In Sect. 3, we present generic and abstract models of inter-organizational competition arising from resource contentions. In Sect. 4, we enumerate the requirements for modeling inter-organizational coopetition with reference to intuitions from SM literature. In Sect. 5, we use modeling to depict the presence of inter-organizational coopetition as manifested in the phenomenon of inter-partner learning and knowledge sharing. In Sect. 6, we discuss the strengths and weaknesses of the modeling language that we adopt for expressing interorganizational coopetition in this paper. In Sect. 7, we review related work and in Sect. 8 we explain our conclusions as well as propose next steps for this research project.

2 Background

Several researchers have noted the need for aligning information systems (IS) with organizational strategy. Pijpers et al. (2008) note that "although 'business strategy' and 'Information Systems' (IS) seem to be quite distant topics, their relationship has been of interest for both the academic and business world." This is partially because "research shows that alignment of IT with business strategy leads to superior business performance" (Bleistein et al. 2004). Carvallo and Franch (2012) point out that "deep understanding of the enterprise context and strategies" are required while designing information systems because "software applications need to be well aligned with business strategies of organizations" (Aurum and Wohlin 2005). Giannoulis et al. (2011a) claim that "ensuring that IT systems are defined and designed in accordance to business strategy" can help enterprises "to solve the always-present problem of business-IT alignment".

Due to these reasons, many IS researchers have incorporated concepts from business strategy into frameworks for designing IS. These researchers have proposed visual and conceptual modeling techniques that are purpose-built for representing organizational strategies. Carvallo and Franch (2012) apply key concepts from Porter's (1979) Five Forces Model to offer a modeling technique for depicting interorganizational competition. Giannoulis et al. (2011a) incorporate main ideas from Porter's (1985) conception of Value Chain into models of information systems. Pijpers et al. (2008) present a modeling technique for expressing the interconnected business strategies of various actors in economic constellations.

Giannoulis et al. (2011b) proffer a modeling technique for articulating balanced scorecard and strategy maps. Samavi et al. (2008) tender a modeling technique for portraying Christensen's (2006) Disruptive Innovation approach. Giannoulis and Zdravkovic (2012) introduce a modeling technique for describing Kim and Mauborgne's (2005) Blue Ocean Strategy. Such modeling techniques enable IS designers to reflect their organizations' strategies in IS requirements. This information can be used to analyze the sufficiency of IS for supporting organizational strategies. Many of these techniques extend extant modeling languages, such as *i** and e3value, by adding entities and relationships that pertain to strategic management (SM) concepts.

The methodical study of interorganizational relationships emerged within the field of SM in the mid-1900s (Ghemawat 2002). SM is concerned with the "creation, success, and survival" of organizations as well as "understanding their failure, its costs, and its lessons" (Rumelt et al. 1991). It is a domain of practice that became a field of scholarly inquiry after World War II (Ghemawat 2002). Several economists were central to its inception and influenced its development as a field of study that was related to but separate from economics (Rumelt et al. 1991).

Over time, as SM matured and became established as a prominent field of research it benefited from the insights of sociologists (Pettigrew et al. 2002). Thus, while SM assumed its own intellectual identity it was shaped by ideas from economics and sociology. One example of the commonality between these three domains can be found in their respective foci wherein each of these disciplines study objects in their contexts – i.e., economists study firms in markets, sociologists study individuals in populations, and SM researchers study organizations in environments.

Throughout the 1980s, competitive and cooperative schools of thought came to dominate SM discourses on interorganizational relationships (Dagnino and Padula 2002). The competitive view argued that firms succeeded by sustaining competitive advantages over their rivals. These enduring differential benefits allowed firms that possessed them to outperform other firms in the markets for factor inputs as well as finished outputs. By contrast, the cooperative view asserted that firms succeeded because of their "relational rents" (Dyer and Singh 1998). These were benefits that accrued to an organization from its partnership-specific idiosyncratic portfolio of capabilities.

By the mid-1990s these dichotonic explanations of interorganizational relationships had become firmly entrenched within the research literature on SM. Contrary to incongruity, observations from the industry indicated that firms adopted a "both/and" approach to competition and cooperation rather than an "either/or" approach (Raza-Ullah et al. 2014). This meant that purely competitive or solely cooperative explanations of interorganizational relationships were incomplete at best and incorrect at worst.

It was during this time that two game theorists proposed an esemplastic theory (Brandenburger and Nalebuff 1996) for harmonizing these antipodal perspectives. Their syncretistic approach prescribed organizations to "cooperate to grow the pie and compete to split it up" (Brandenburger and Nalebuff 1995). It was related to game theory research in the areas of biform games (Brandenburger and Stuart 2007) and value based business strategies (Brandenburger and Stuart 1996). Coopetition encouraged organizations to cooperate for achieving joint objectives while competing to maximize their individual gains (Nalebuff and Brandenburger 1997).

Coopetition research has experienced a surge in prominence in the two decades since its introduction. A number of literature reviews[1] as well as special editions of scholarly journals[2] have noted the proliferation of academic papers on this subject in peer reviewed publications. Moreover, coopetition research has moved beyond the realm of SM and has been applied by researchers to discourses in diplomacy (Alber et al. 2006), civics (Racine 2003), and political science (Fleisher 2001).

3 Modeling Strategic Competition Caused by Resource Contentions

Before we consider how coopetition can be approached through modeling, we first consider how competition might be modeled and analyzed. Several theories have been proposed to explain the nature and characteristics of strategic competition between enterprises. These include Industrial Organization, Chamberlinian, and Schumpeterian explanations that refer to different core concepts and units of analysis (Barney 1986). For example, Henderson (1983) claims that "there is no reason to think of business competitive systems as different in any fundamental way from other biological competition". This view posits that much like biological competition (between organisms) economic competition (between enterprises) occurs due to contention over resources (Henderson 1981). Indeed, this view is in line with a functional definition of economics as the "study of the allocation of 'scarce' resources among competing ends" (Chiswick 2009). This means that some facets of inter-organizational relationships, that are relevant for modeling strategic competition, include actors, goals, and resources.

In this paper, we adopt *i** (distributed intentionality) to model competition caused by contention over resources. We acknowledge that modeling strategic competition caused by other reasons may require other approaches to modeling. We use *i** because it incorporates assumptions about the real-world properties of actors that are relevant for understanding contention and rivalry. These properties include intentionality, autonomy, sociality, contingency (of identity/boundary), reflectivity, and rationality (in seeking self-interest) (Yu 2001). Each of these properties explain different facets of competitive motives of actors and can be used to understand 'why' and 'how' actors compete. Due to these reasons, *i** has been applied, in the peer-reviewed

[1] Select literature reviews that appeared in peer-reviewed publications include: (Walley 2007), (Czakon et al. 2014), (Gast et al. 2015), (Bouncken et al. 2015), (Bengtsson and Raza-Ullah 2016), and (Dorn et al. 2016).

[2] Select special editions of scholarly journals include: (Dagnino (ed.) 2007), (Baglieri et al. (eds.) 2008), and (Roy and Czakon (eds.) 2016).

literature, to represent competitive strategies of organizations (Carvallo and Franch 2012; Samavi et al. 2008).

*i** supports two types of models which are Strategic Rationale (SR) and Strategic Dependency (SD) diagrams. SR diagrams support the representation of internal intentional structures of actors while SD diagrams support the depiction of intentional relationships between actors through their dependencies. Through SR and SD diagrams, *i** offers reasoning support for analyzing the internal intentions (Subramanian et al. 2015), goals (Kethers et al. 2005), and strategies (Bencomo et al. 2012) of actors. See Yu (1997) for a detailed description of *i**.

Figure 1 presents an *i** SR (Strategic Rationale) diagram of competition between enterprises that is caused by common types of resource contentions. Consider the relationship between two firms, A and B, that are represented as actors. These actors are in the same industry such that their products/services are substitutes that serve similar customer needs. These actors require similar assets (capital and employees) and consume similar raw materials (ingredients and supplies). These assets and raw materials are represented as resources, which can be used to refer to physical or informational entities that are required to achieve some goal or perform some task. These focal actors, apply these resources to achieve certain subjective and qualitative goals such as producing a good or selling a good. Such objectives can be depicted as softgoals which refer to goals without well-defined criteria for satisfaction and which requires further refinement and elaboration for assessing achievement.

The objectives of these actors, such as procuring raw material or recruiting an employee, are depicted as goals. A goal refers to an end, objective, aim, or target that reflects a state of affairs to be achieved. The way by which an actor can achieve its goal is represented as a task which refers to an alternative mean for satisfying some goal. These actors interact with each other in two arenas which are factor and output markets wherein a factor market is comprised of investors, suppliers, and job agencies while an output market is comprised of customers, and an intellectual property office (e.g., authority that issues patent). Each of these stakeholders are also depicted as actors and the resources over which they have control are inscribed within them.

In *i**, an actor (the depender) depends upon another actor (the dependee) for something (the dependum). For example, in Fig. 1, Firm A (depender) depends on a customer (dependee 1) for an order (dependum 1). It also depends on an investor (dependee 2) for capital (dependum 2). A depender benefits through its collaboration with a dependee because it can seize opportunities to satisfy objectives that it cannot fulfill alone. However, actors in *i** are autonomous and make self-interested decisions. Thus, a dependency also makes a depender vulnerable because a dependee may choose to deny a dependum at its sole discretion.

In *i**, the main links are contribution, dependency, means-ends, and decomposition. Contribution links are used to depict the impact of one element on another. The impact upon an element can be positive, negative, or unknown. For example, hiring a worker helps a firm to produce a good and selling a good helps a firm to earn revenue. Dependency links are used to express the relationship between dependers (those who depend) and dependees (those who are depended upon) via dependums (the subjects of the dependencies). For example, to get capital a firm depends on an investor for funding and to register a patent a firm depends on an intellectual property office to enroll its idea. Means-Ends links are the links between a goal and the alternative tasks for achieving it such that the completion of any task leads to the satisfaction of its associated goal. Decomposition links are the links between an element and its sub-elements such that the achievement of all sub-elements is necessary for the satisfaction of their associated element.

Each firm depends on these stakeholders for different reasons. An investor offers funds to firms (shown) in return for principal + interest and/or profits (not shown). A supplier sells raw materials to firms (shown) in return for principal + interest and/or profits (not shown). A job agency helps a firm to recruit employees (shown) in return for a charge (not shown). The Intellectual Property Office issues patents (not shown) after a firm attempt to register its design (shown). A customer offers its business to firms via orders (shown) and in return pays the firm for its products (not shown). It should be noted that, only certain dependencies are show in Fig. 1 to simplify the visual presentation of the diagram. This is not deleterious for the type of analysis that this model is intended to facilitate because the shown dependencies are sufficient for the purposes of demonstrating the presence or absence of strategic competition between different actors.

The ability to represent the heterogeneous facets of resources is relevant for the modeling and analysis of strategic competition between enterprises. This is because Barney (1991) argues that a resource that is valuable, rare, inimitable, and non-substitutable serves as a source of competitive advantage for its owner/controller. A resource is considered valuable if it can be used to generate value, benefit, or utility for its owner/controller. Moreover, it is considered to be even more valuable if rivals cannot: obtain/access it (i.e., rare), mimic/copy it (i.e., inimitable), or generate comparable value, benefit, or utility from alternative/replacement resources (i.e., non-substitutable). Barney (2001) further notes that “it is almost as though once a firm becomes aware of the valuable, rare, costly to

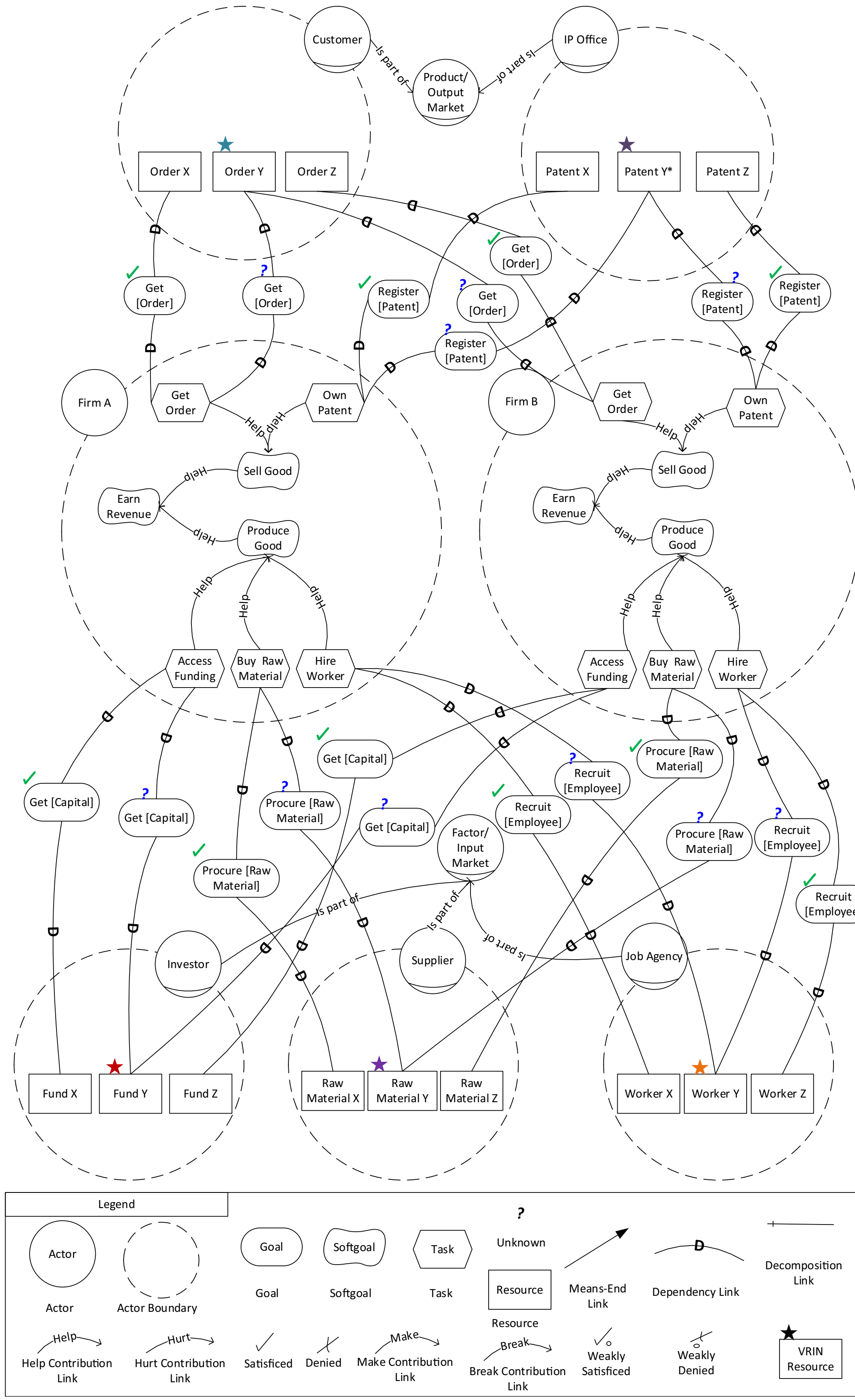

Fig. 1 *i** SR diagram of competition from common types of resource contentions among enterprises

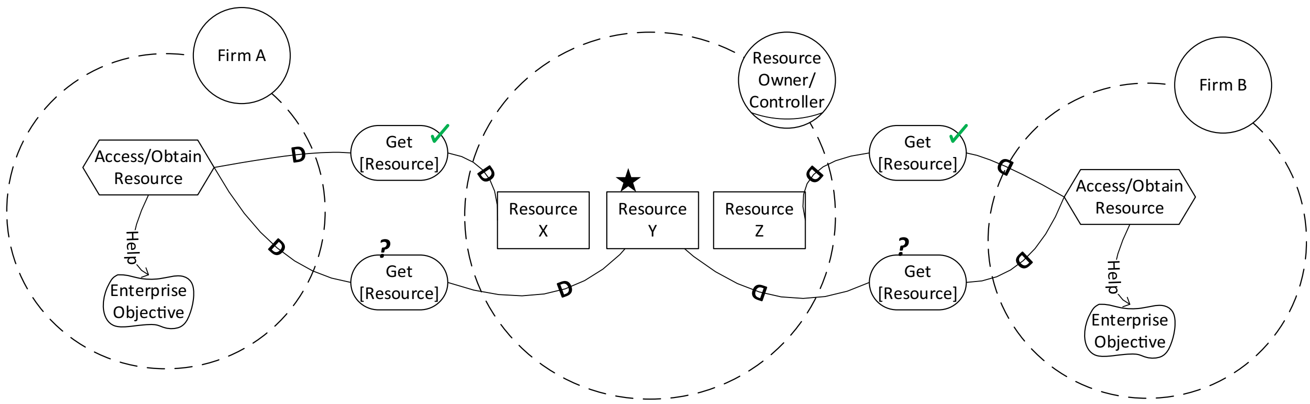

Fig. 2 *i** SR diagram of competition depicting abstract resource contentions among enterprises

imitate, and nonsubstitutable resources it controls, the actions the firm should take to exploit these resources will be self-evident."

We slightly extend *i** for representing VRIN (Valuable, Rare, Inimitable, and Non-substitutable) resources as such resources can lead to resource contentions between actors. Resource contention is a context dependent occurence that can potentially deny a dependum if another dependum also relies on the same VRIN resource and only one of the contentious dependums can be satisfied. We denote VRIN as a property of a resource because a resource will only be VRIN from the perspective of certain actors that depend upon it. For example, two small retailers may be competing for the last vacant storefront within the only mall in their local area such as a town. For each of these retailers that storefront is VRIN because neither of them have the option of renting a storefront at a different mall in another town for logistical reasons. However, this storefront is not VRIN for two rival multinational retailers as they can simply rent a storefront at a mall in another town if they are unable to rent this specific storefront.

The star symbol atop a resource element represents a VRIN resource while question mark symbols signify contentious dependums whereby the satisfaction of one dependum denies other corresponding dependums. This symbol should be interpreted in the following manner: a resource is VRIN therefore it will be the subject of contention and therefore only one of the contesting dependums will be satisfied. As it is not known a priori which of the contesting dependums will be satisfied therefore the satisfaction or denial of each contesting dependum will be marked as Unknown. This symbol helps to differentiate VRIN resources from non-VRIN resources. This is important because the same resource can be the subject of multiple dependencies in such a way that each of those dependums are satisfied (i.e., the resource is not VRIN) or that only one of those dependums are satisfied while the other are denied.

There are two main types of relationships that can take place between two enterprises such as firms A and B. These are depicted in Fig. 2 which is an *i** Strategic Rationale (SR) diagram of abstract resource contentions between enterprises. Figure 2 decontextualizes the scenarios that are presented in Fig. 1 to isolate the strategic patterns that undergird competitive relationships. This distillation through abstraction allows for easier detection of competitive configurations in models with details that are specific to a domain and relevant to a context. *i** models can be used ex ante to design strategies for increasing or decreasing competition and they can also be used ex post to identify contentions along with their sources and causes.

In the first type of relationship, an enterprise (e.g., Firm A) depends on a resource (i.e., Resource X) while another enterprise (e.g., Firm B) depends on a different resource (i.e., Resource Z). In this case, there is no competition between these enterprises as they depend on, and are interested in, different resources. In the second type of relationship, two enterprises (e.g., Firm A and Firm B) depend on the same resource (i.e., Resource Y). In this case, there is contention between these enterprises as they depend on, and are interested in, the same resource. This scenario is likely to lead to strategic competition because only one of these firms will be able to satisfy its resource dependency (means) that is necessary for achieving its goal (ends).

4 Requirements for Modeling Inter-organizational Coopetition

4.1 Tensions in Paradoxical Relationships

Competition and cooperation are diametric social behaviors that are undergirded by opposite logics and assumptions (Bengtsson and Kock 2000). Their co-occurrence in any relationship represents a paradox that creates tensions

Table 1 List of requirements for modeling enterprise coopetition

Characteristics	Features	Key	Description for modeling support
Actor	2 actors or dyad	A1	Two actors with links between them
	> 2 actors or network	A2	More than two actors with links between them
	Actor intention	A3	Internal intentional structure of actor(s)
Complementarity	Resource/asset/object	C1	Entity associated with some value, benefit, or utility
	Value added	C2	Incremental addition of some value, benefit, or utility
	Added value	C3	Worth of an actor in terms of value, benefit, or utility
Interdependence	Positive dependency	I1	Existence of dependency(ies) between actors
	Negative dependency	I2	Non-existence of any dependency between actors
	Strength of dependency	I3	Magnitude of dependency (however measured)
Trustworthiness	Goal convergence	T1	Agreements between goals within and across actors
	Goal divergence	T2	Conflict between goals within and across actors
	Compliance	T3	Evaluation of abidance with terms and conditions
Reciprocity	Activity or task	R1	Individual (step) or collection (process) of actions
	Sequence	R2	Transition from predecessor to successor action
	Condition	R3	Constraints or restrictions on actions

between the coopeting actors (Raza-Ullah et al. 2014). Different degrees of cooperation and competition can co-exist (Bengtsson et al. 2010; Bengtsson and Kock 2000) within vertical (i.e., buyer–supplier) as well as horizontal (i.e., firm-to-firm) relationships (Dowling et al. 1996). Moreover, coopetition can occur within a dyad (i.e., between two actors) or in a network (Czakon et al. 2014). Dyadic coopetition necessitates direct coopetition between two actors but network coopetition enables direct as well as indirect coopetition (i.e., via an intermediary). Dyadic coopetition can be regarded as procedural coopetition (Rusko 2012) where activity is an appropriate unit of analysis while network coopetition can be regarded as contextual coopetition (Rusko 2014) where actor is a suitable unit of analysis. Coopetition is also a multilevel phenomenon wherein an actor may exhibit different behaviors at different levels (i.e., within a dyad or network) (Chiambaretto and Dumez 2016).

4.2 Key Features of Inter-organizational Coopetitive Relationships

Researchers have identified various characteristics that define coopetitive relationships (Gnyawali and Park 2009; Zineldin 2004; Chin et al. 2008; Bonel et al. 2008; Bengtsson et al. 2010). These include complementarity (Tee and Gawer 2009), interdependence (Luo 2005), trustworthiness (Bouncken and Fredrich 2012), and reciprocity (Rossi and Warglien 2000). Moreover, it should be noted that cooperation and competition are germane to coopetition because coopetition represents the coaction of these phenomena. In this paper, we include the modeling of strategic competition (in Sect. 3) as well as inter-organizational coopetition (in Sect. 5) but omit the modeling of cooperation between enterprises due to space constraints.

Table 1 presents a list of requirements that are relevant for modeling coopetition phenomenon. Requirements in Table 1 were derived intuitively based on a comprehensive review of literature on inter-organizational coopetition. Prior experiences of the authors in enterprise modeling informed the selection of these characteristics and features. Table 2 presents an assessment of various techniques in terms of requirements for representing coopetition at the enterprise-level. The selection of the techniques as well as their evaluation in Table 2 reflects a subjective and qualitative evaluation on the part of the authors. More thorough selection and evaluation of these techniques is identified as an area for future work. The techniques in Table 2 were selected because they were found to have been frequently applied, in the scholarly literature or practitioner press, to represent organizational strategy. We acknowledge that these are not the only techniques that can be used to model organizational strategy and other modelers can use these techniques in diverse ways to obtain different evaluation results.

It should be noted that this assessment does not consider the syntax and semantics of extensions, derivatives, or combinations of the reviewed techniques. Prominent goal- and/or actor-modeling approaches such as NFR framework, KAOS, and *i** support the representation of some, but not all, of these requirements. Similarly, practitioner tools such as Business Model Canvas and Value Network Analysis are also deficient with respect to some of these requirements. Nonetheless, these approaches can be extended and combined in creative ways to overcome their

Table 2 Assessment of modeling support for requirements from Table 1

Technique	A1	A2	A3	C1	C2	C3	I1	I2	I3	T1	T2	T3	R1	R2	R3
NFR Framework (Chung et al. 2000)	×	×	×	×	×	×	×	×	×	✔	✔	×	✔	×	×
*i** (Yu 1997)	✔	✔	✔	✔	×	×	✔	×	×	✔	✔	×	✔	×	×
KAOS (Dardenne et al. 1993)	✔	✔	×	✔	×	×	×	×	×	×	✔	×	✔	✔	✔
e3Value (Gordijn et al. 2006b)	✔	✔	×	✔	✔	×	×	×	×	×	×	×	✔	✔	×
Business Model Canvas (Osterwalder and Pigneur 2010)	×	×	×	✔	✔	×	×	×	×	×	×	×	✔	×	×
Value Network Analysis (Allee 2008)	✔	✔	×	✔	×	×	×	×	×	×	×	×	×	×	×
Game Tree (Dixit and Nalebuff 2008)	✔	×	×	×	✔	×	×	×	×	×	×	×	✔	✔	×
Payoff Table (Dixit and Nalebuff 2008)	✔	×	×	×	✔	×	×	×	×	×	×	×	✔	×	×
Change Matrix (Brynjolfsson et al. 1997)	✔	×	×	×	✔	×	×	×	×	×	×	×	✔	×	×

respective limitations for modeling and analyzing coopetition. This section discusses the key characteristics of coopetition that are essential for representing it.

4.2.1 *Complementarity*

According to Tee and Gawer (2009),"complementarity refers to the combined returns from the combination of two or more assets, with some combinations resulting in higher value creation than other combinations." It is informally referred to as synergy wherein: 'the whole is greater than the sum of its parts'. Complementarity motivates cooperation within competitive relationships and competition within cooperative relationships. Researchers have identified various ways through which firms can develop complementarities with their partners. These include overlap avoidance (Khamseh and Jolly 2014), knowledge protection (Haeussler et al. 2012), and development of common objectives (Martinelli and Sparks 2003). Gnyawali and Park (2011) note that multifaceted dealings between Sony and Samsung illustrate a coopetitive relationship that is based on complementary R&D and manufacturing skills.

4.2.2 *Interdependence*

Luo (2005) states that, "strategic interdependence is concerned with the extent to which work processes that have strategic implications are interrelated." Firms are typically incentivized to become mutually reliant when they have "partially congruent interest structures" (Castaldo and Dagnino 2009). Interdependence fosters coopetition because it ensures that "each competitor will have a specific individual interest in carrying out an agreement" (Garraffo and Rocco 2009). Researchers have identified various ways through which firms can become more interdependent with each other. These include investing in relationship-specific assets (Paché and Medina 2007), interconnecting resources (Wieland and Wallenburg 2013), and knowledge sharing (Baumard 2009). Bengtsson and Kock (2000) observed such coopetitive relationships between many European firms in the rack and pinion as well as lining industries.

4.2.3 *Trustworthiness*

According to Hutchinson et al. (2012), "trust refers to the expectation that another business can be relied on to fulfill its obligations." It "is expected to reduce the level of potential and actual opportunism" (Judge and Dooley 2006) through "(a) impartiality in negotiations, (b) trustworthiness, and (c) keeping of promises" (Bouncken and Fredrich 2012). Moreover, "while trust is an attribute of a relationship between exchange partners, trustworthiness is an attribute of individual exchange partners" (Barney and Hansen 1994). Trustworthiness is an important consideration in coopetition because trust and contracts serve as governance mechanisms in cooperative relationships. Researchers have identified various techniques through which firms can grow their trustworthiness. These include increasing communication (Zach 2013), avoiding coercion (Jain et al. 2014), and increasing linkages (Park et al. 2014). Fernandez et al. (2014) identified trust as a "key factor for success of co-opetitive strategies" through an empirical study of the telecommunications satellite industry in Europe.

4.2.4 Reciprocity

Ashraf et al. (2006) define reciprocity as,"rewarding kindness with kindness and punishing unkindness with unkindness." Sobel (2005) notes that a social actor should "expect this behavior from others" because "reciprocity is a rather stable behavioral response by a nonnegligible fraction of the people" (Fehr and Gächter 2000). Lee et al. (2010) point out "reciprocity has been studied in depth in economics and game theory as a means to enforce cooperative behavior". As such, it is commonly used in game theory to explain social behavior in sequential move games such as ultimatum game and gift-exchange game (Falk and Fischbacher 2006). In fact, such behavior is not limited to games and has been observed in the industry by Krämer et al. (2016).

5 Example: Inter-partner Learning and Knowledge-sharing Among Enterprises

Organizations set up strategic alliances to exchange complementary knowledge with their trusted partners (Jiang and Li 2009; Todeva and Knoke 2005). However, knowledge sharing among partners is not always a reciprocally beneficial activity. This is because partners can engage in 'learning races' (Kale et al. 2000; Khanna et al. 1998) where each firm tries to 'learn faster' than its partners (Carayannis et al. 2000; Petts 1997). This might be motivated by opportunism such as a firm's desire for 'knowledge expropriation' (Heiman and Nickerson 2004; Ritala et al. 2015; Sampson 2004; Trkman and Desouza 2012). Such strategic relationships between enterprises necessitate the ability to model and analyze complementarity, interdependence, trustworthiness, and reciprocity.

Figure 3 shows the strategic dynamics between two enterprises (i.e., Firm A and Firm B) that possess complementary knowledge. This means that each possesses a stock of information that is of use to the other and hence these firms are interdependent on each other. Information stock is a resource that allows each firm to make decisions regarding several business activities. These decisions include, but are not limited to, those about entering new markets, designing new products, developing new business processes, building new organizational structures, and creating new business relationships.

Each firm identifies learning opportunities from its partner by evaluating the usefulness of the information stock of its partner for its own business requirements. After identifying learning opportunities, a firm tries to access information from the information stock of its partner to add it to its own information stock. However, to access information from its partner a firm should disclose information from its own information stock. This is necessary because both firms must act on complementary learning opportunities for information exchange to be reciprocally beneficial.

A firm can exchange information with its partner through two main methods which are accessing and disclosing information. Accessing and disclosing information are two components of the same process because accessing information depends on the ability of a firm to get information from a dependee (i.e., someone that is depended upon) as well as the ability of the dependee to give information to the depender (i.e., someone that is depending). Likewise, disclosing information depends on the ability of a firm to give information to a depender as well as the ability of the depender to get information from the dependee. Disclosing information requires the presence of trust because distrust and mistrust can expose partners to possible exploitation.

In such inter-partner learning arrangements, each firm must disclose its information stock to its partner to access the information stock of its partner in return. Learning ability is a socio-technical resource that enables activities related to the acquisition, assimilation, absorption, and application of organizational knowledge. This resource allows a firm to learn from its partners and makes it possible for a firm to learn faster than its partner (i.e., allows it to get more information than it gives). The ability to learn faster than a partner is advantageous for a firm because it allows that firm to achieve a higher return from the sharing of its knowledge. Indeed, Jashapara (2003) argues that superior organizational learning leads to improved organizational performance and that "the only source of sustainable competitive advantage for a company may lie in its ability to learn faster than its competitors" (Jashapara 1993).

A superior learning ability also functions as de facto insurance policy in a relationship where the partners are interdependent on each other. This is because it precludes a partner from being shut out from the information stock of its partner before it has had a chance to access all the information that it is seeking from that partner. Conversely, a firm that can learn faster than its partner can access all the relevant information from the information stock of its partner first and then terminate the knowledge sharing arrangement before that partner has had an opportunity to learn all the relevant information from its information stock. Therefore, firms evaluate the trustworthiness of partners to minimize the risk of exploitation through opportunism (e.g., knowledge expropriation) in knowledge-sharing scenarios.

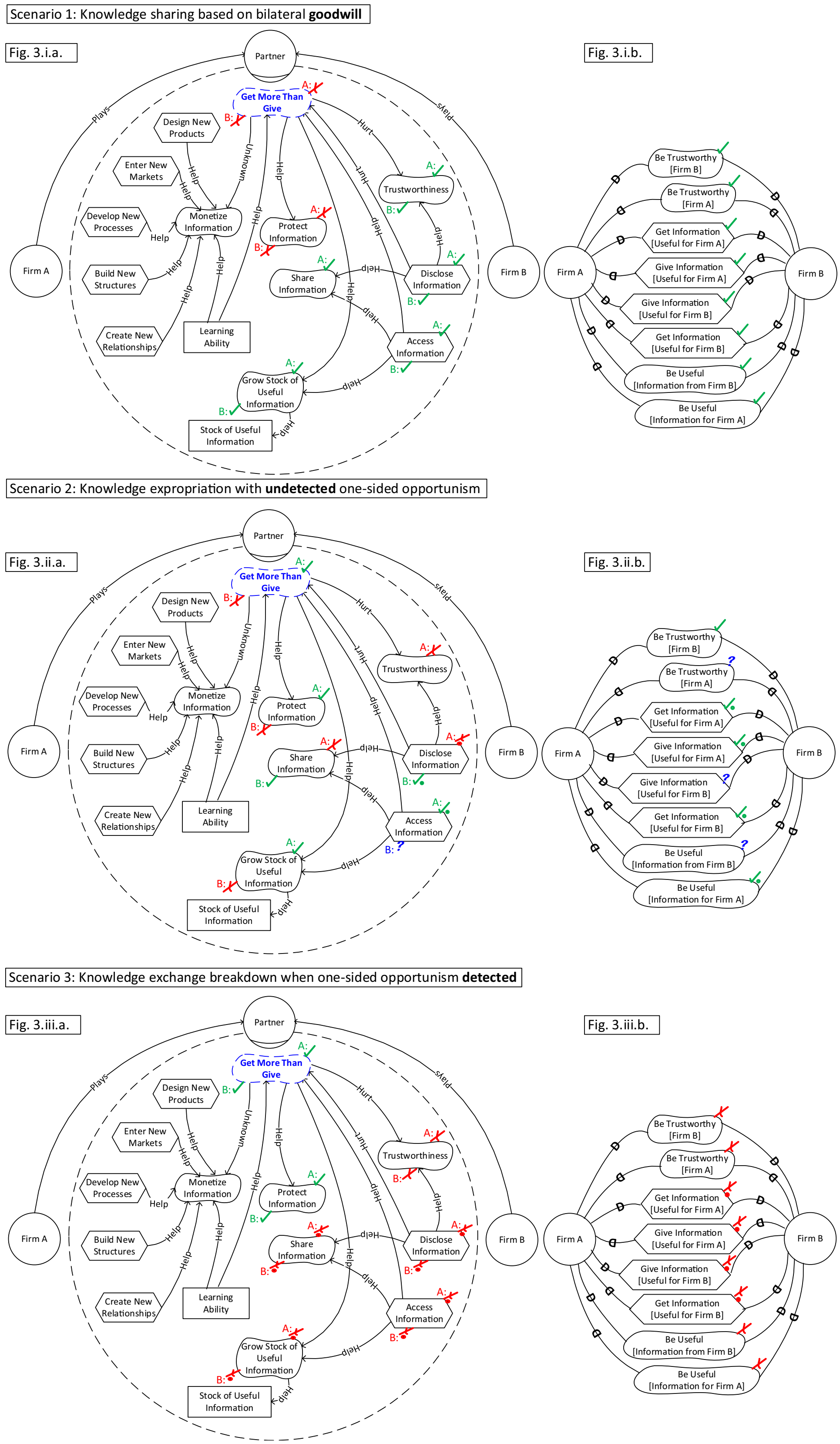

Fig. 3 *i** strategic dependency and strategic rationale diagrams of inter-partner learning and knowledge sharing

There are three main types of relationships that can take place between two enterprises (e.g., firms A and B) for inter-partner learning. These are knowledge sharing based on bilateral goodwill, knowledge expropriation with undetected one-sided opportunism, and knowledge exchange breakdown when one-sided opportunism detected. These are depicted as three pairs of *i** Strategic Rationale (SR) and *i** Strategic Dependency (SD) diagrams. Figures 3.i.a., 3.ii.a, and 3.iii.a are *i** SR diagrams while Fig. 3.i.b., 3.ii.b., and 3.iii.b are their corresponding *i** SD diagrams. In each *i** SR diagram the softgoal "Get More Than Give" is positioned at the top to indicate that it is root goal that guides behavior of the actors. An actor decides whether it wishes to satisfy this softgoal first and then chooses tasks that increase its likelihood of achieving that outcome. That actor attempts to satisfy other softgoals for satisfying or denying the softgoal labeled "Get More Than Give". Thus, the analysis of these scenarios commences with whether an actor wishes to satisfy or deny this softgoal.

An example of the importance of a decision regarding the softgoal "Get More Than Give" is found by evaluating the outcomes of the softgoal "Grow Stock of Useful Information". We have modeled growing stock of useful information as a softgoal because whether a unit of information is considered to be useful for a firm depends on the analyst evaluating that unit of information. Firm A may give information to a Firm B that technically grows the information stock of Firm B however that information may or may not be useful for Firm A. Some analysts may determine that information from Firm B to be useful for Firm A whilst other may deem it to be useless. Thus, "Grow Stock of Useful Information" is represented as a softgoal as the usefulness of a unit of information depends on the intended user of that unit of information as well as the analyst evaluating usefulness for that user.

In each of the three scenarios the outcomes of the softgoal labeled "Grow Stock of Useful Information" for firms A and B depend upon their choices and those of their partners regarding the softgoal labeled "Get More Than Give". In the first scenario, represented in Fig. 3.i.a. neither of the firms attempt to deny their respective softgoals labeled "Get More Than Give" and thus each of their respective softgoals labeled "Grow Stock of Useful Information" are satisfied. In Fig. 3.iii.a. both of the firms attempt to satisfy their respective softgoals labeled "Get More Than Give" and thus their respective softgoals labeled "Grow Stock of Useful Information" are denied. In Fig. 3ii.a firm A attempts to satisfy its softgoal labeled "Get More Than Give" while firm B intentionally avoids a softgoal labeled "Get More Than Give" which leads to the softgoal labeled "Grow Stock of Useful Information" to be satisfied for firm A but to be denied for firm B. These outcomes are different because the softgoal "Get More Than Give" helps to achieve the softgoal "Grow Stock of Useful Information". The labels in Fig. 3 are propagated manually for the softgoal labeled "Get More Than Give" as that is a decision that will be undertaken by the focal actors. The remaining labels are propagated based on the contribution links from the softgoal labeled "Get More Than Give" to the model elements associated with those outcome labels.

Scenario 1 in Fig. 3 depicts a situation in which both partners perceive the knowledge exchange to be equitable as well as fair and therefore they will continue to cooperate by sharing complementary knowledge. This might happen if both partners have foregone opportunism in their past dealings and have built up a reservoir of trust through acts of reciprocal goodwill. In contrast, scenario 2 in Fig. 3 depicts a situation in which neither partner perceives the knowledge exchange to be equitable or fair and therefore they will conflict and compete. This might happen if either partner detects the other party to be engaged in opportunistic behavior and will lead to retaliation which will impair the interdependence between the partners.

Scenario 2 in Fig. 3 depicts a situation in which a partner (i.e., Firm B) has not detected the opportunistic behavior of its partner (i.e., Firm A). In such a situation, Firm B continues to grant unrestricted access to its information stock to Firm A while Firm A only grants partial access to its information stock to Firm B. In such a case, there is simultaneous competition and cooperation between the actors because both actors are cooperating with each other, albeit to different extents. While one firm is cooperating fully (i.e., Firm B) the other firm (i.e., Firm A) is cooperating partially because it is also attempting to learn faster than its partner (i.e., it is competing).

Analysis of the three scenarios in Fig. 3 lead to the following insights about coopetition in inter-partner learning and knowledge sharing scenarios:

- Knowledge sharing based on trust and reciprocity can lead to a stable mutually beneficial equilibrium state.
- Knowledge exchange based on trust from one partner but opportunistic behavior from the other partner can only lead to a stable equilibrium if the exploitative behavior is not detected. It can also lead to a disequilibrium state if the invidious purports of the maleficent actor are detected by the well-behaving partner.
- Knowledge expropriation based on unilateral opportunistic and exploitative behavior can lead to a stable mutually harmful equilibrium state when detected and can damage interdependence between the partners.

6 Discussion

Based on our preliminary study, we discuss the suitability of *i** for modeling coopetition. The following limitations and inadequacies of *i** impeded our attempts to fully express coopetition. These obstacles to comprehensive expression of coopetition include:

- Temporal support – *i** does not support the concept of absolute or relative time. In coopetitive relationships the history of moves and countermoves by firms from an earlier time can have an impact on the space of available alternatives for firms at a later time. Modeling this kind of path dependency requires a modeler to show time as well as sequence in the *i** model. For example, we were not able to show sequence or history in the same model and had to make multiple models to represent three scenarios in Fig. 3. Thus, extension of *i** with temporal support will improve its expressiveness vis-à-vis coopetition modeling. We acknowledge that Tropos which, extends *i**, offers real-time linear temporal reasoning support (Castro et al. 2002).
- Quantitative reasoning – While elements in *i** can be parameterized with numerical values, *i** does not natively support quantitative reasoning. In coopetitive relationships, comparison of alternatives may be predicated upon considerations of economic impact or business value which will necessitate quantitative reasoning. For example, we were not able to model financial or economic impacts in numerical terms in our models and thus had to omit these aspects from our models. Therefore, extension of *i** to support quantitative reasoning will increase its expressiveness with respect to modeling of coopetition. We acknowledge that Goal-oriented requirements language (GRL), which is a derivative of *i**, supports certain types of quantitative reasoning (Mussbacher 2007).
- Conditional logic – While dependencies and contribution links can be used to infer some type of conditionality indirectly, *i** does not support the depiction of conditionality directly. In coopetitive relationships certain alternatives may or may not be available if other alternatives are satisfied or denied. It is not possible to show relationships of inclusivity or exclusivity in *i** and therefore extension of *i** with support for representation of conditionality will improve its expressiveness with respect to modeling coopetition. For example, we were not able to clearly show sequences in our models and had to explain this via accompanying text. We acknowledge that some researchers have combined *i** with BPMN for depicting conditionality in process flows (Koliadis et al. 2006).
- Visual scalability – In spatial terms, *i** models can become quite large and dense if they contain a large number of highly interrelated elements. In coopetitive scenarios, multiple firms may compete and cooperate with other in a myriad of ways. Showing all the relevant actors and their internal intentional elements as well as their external dependencies might yield a model that occupies a large amount of space and is difficult for a human analyst to grasp. For example, we found contribution links and dependency lines were difficult to configure in ways that avoided overlapping and curving.
- Semantic complexity – A generalized socio-technical ontology serves as the foundation of the *i** framework. This allows modelers to analyze *i** models in a consistent and coherent manner. This ontology specifies the manner in which elements should be added to models and their relationships must be depicted using prescribed guidelines. These requirements can confuse some novice *i** modelers and might increase their learning curve. For example, we did not need to use many of the *i** constructs in our models. Ongoing attempts to simplify the semantics and notation of *i** are steps in the right direction.

On the positive side, we were able to use *i** to model: relationships rather than transactions (e.g., we were able to show dependencies moderated by trust), link between a cause (e.g., opportunism) and its consequences (e.g., retaliation), abstract patterns and decontextualized representations of phenomena with many variants (e.g., resource contentions), trade offs between alternative courses of action (e.g., act opportunistically or responsibly), and, with a slight extension to *i**, context dependency of an element (e.g., VRIN property of a resource).

7 Related Work

Currently, there is a dearth of modeling based approaches for representing and reasoning about interorganizational coopetition in a structured and systematic manner. Game theorists have proposed the Value Net approach (Brandenburger and Nalebuff 1995, 1996; Nalebuff and Brandenburger 1997) for analyzing coopetitive relationships. However, this approach is suitable for descriptive, but not explanatory, application because it lacks an ontology as well as semantic support which makes it vulnerable to arbitrary usage. Similarly, game theorists have proposed quantitative tools and techniques such as game trees and payoff tables (Dixit and Nalebuff 2008) that can be used to reason about coopetition. However, these techniques are suitable for evaluating pre-set solutions to predefined problems. They are not conducive to generative and exploratory analysis in which the design space is refined and elaborated progressively over successive iterations with new problems and solutions introduced in each round.

Within the field of Enterprise Modeling (EM), several researchers have explored social behaviors among organizations (Giannoulis et al. 2011a; Liu et al. 2009). Researchers also have proposed modeling notations and techniques for expressing and evaluating organizational strategy, that encompasses such social relationships (Giannoulis et al. 2011b; Weigand et al. 2007; Gordijn et al. 2006a; Osterwalder et al. 2005). These modeling approaches have been developed to describe different aspects of enterprises (e.g., goal, actor, value, process, etc.) (Johannesson 2007). Additionally, researchers have applied many goal- and actor-oriented approaches to model and analyze business strategies that include these social behaviors (López and Franch 2014; Paja et al. 2016; Carvallo and Franch 2012).

However, even though coopetition impacts many of the enterprise-level entities that are of concern to these approaches (such as goals, tasks, resources, boundaries, etc.) – none of these approaches have focused directly on this counterintuitive social phenomenon. It can be argued that these gaps "make it difficult for requirements engineers to validate low-level requirements against the more abstract high-level requirements representing the business strategy" (Bleistein et al. 2004). This ability to model coopetition between enterprises is useful for information system designers as it can inform decisions about transaction processing, data sharing, compliance monitoring, and process integration. Therefore, the ability to model and analyze cooperation, competition, and coopetition between enterprises represents advancement in the state-of-the-art in EM.

8 Conclusions and Future Work

This paper provided an overview of the phenomenon of coopetition as well as some of its key facets and characteristics that are relevant for enterprise modeling. Coopetition is widely observed in practice and consequently it is also an eminent research area (Bouncken et al. 2015). Baglieri et al. (2012) claim that "coopetition is common in several industries" and Harbison and Pekar (1998) note that roughly 50% of strategic alliances are between competitors. Nonetheless, in spite of its prominence, coopetition has not been explored in the enterprise modeling literature. We intend to address this shortcoming by contributing to the development a modeling framework that is suitable for analyzing cooperation, competition, and coopetition.

In this paper we proposed models of certain types of coopetitive relationships. We started with the generic version of *i** but are aware that there are many relevant extensions of *i**. While none of these extensions deal specifically with coopetition they offer useful lessons or insights for modeling coopetition (e.g., from security, risk, and policy/regulatory compliance and enforcement).

Table 1 presents a list of these requirements however it can benefit from further elaboration and refinement. The next logical step in this research area is to identify and catalog the requirements for modeling these phenomena. After identifying the requirements for modeling coopetition, a next step can be the assessment of the adequacy of extant modeling languages for satisfying those requirements. Table 2 presents relevant findings however we invite researchers to improve them through more rigorous and detailed assay. Moreover, any revisions to Table 1 will necessarily require Table 2 to be revised as well.

After evaluating modeling languages, from Table 2, in terms of their sufficiency for satisfying the requirements from the catalog, in Table 1, a next step will be to address the shortcomings of those modeling languages. This can be done by developing a conceptual modeling framework that extends and combines extant notations and techniques. To verify this framework, it will be fruitful to share it with management practitioners. Additionally, it will be beneficial to collaborate with industry partners to validate this framework in the field. Published and empirical case studies will be useful for refining and elaborating the artefacts that emerge from this research project. Case studies, that are relevant for this research project, will be those that focus on the coopetitive relationships of an organization. Case studies will concentrate on the utility of the modeling framework for analyzing coopetition at focal organizations in contrast to ad-hoc or unsystematic/unstructured analysis.

This enterprise modeling framework will be purpose built for depicting the main characteristics that are relevant for modeling and analyzing abstract patterns and decontextualized representations of coopetition. It will allow the exploration of opportunities for coopetition as well as the evaluation of strategic alternatives in a structured and systematic manner. Overall, our eventual objective is to provide a model-based approach for IS designers and strategists to understand and analyze the impact of coopetition on IS design decisions and vice versa. This framework will represent a contribution towards advancing the state-of-the-art in enterprise modeling (Pant and Yu 2016).

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