Addressing Tensions in Coopetition for Sustainable Innovation: Insights from the Automotive Industry

Pauline Munten
Université catholique de Louvain, Louvain Research Institute in Management and Organizations (LouRIM), Belgium. E-mail: pauline.munten@uclouvain.be

Joëlle Vanhamme
EDHEC Business School, France. Email: Joelle.Vanhamme@edhec.edu

François Maon
IESEG School of Management, France & LEM-CNRS 9221, France. E-mail: f.maon@ieseg.fr

Valérie Swaen
Université catholique de Louvain, Louvain Research Institute in Management and Organizations (LouRIM), Belgium & IESEG School of Management, France & LEM-CNRS 9221, France. E-mail: valerie.swaen@uclouvain.be

Adam Lindgreen*
Copenhagen Business School, Denmark and Gordon Institute of Business Science, University of Pretoria, South Africa. E-mail: adli.marktg@cbs.dk

*** Corresponding author:** Adam Lindgreen, Department of Marketing, Copenhagen Business School, Solbjerg Plads 3, 2000 Frederiksberg C, Denmark and Gordon Institute of Business Science, University of Pretoria, 26 Melville Road, Illovo, Johannesburg, South Africa. Telephone: +45 3815 2111. E-mail: adli.marktg@cbs.dk.

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Abstract

Developing solutions to sustainability challenges requires cooperation among various firms and actors in different industries and sectors (e.g., regulatory authorities, nonprofit organizations). Prior studies investigate sustainability-related coopetition tensions in bilateral relationships; this article instead considers tensions at a broader, value net level and highlights the dark side of business relationships for firms engaged in coopetition. Qualitative analyses, based on interviews with 31 experts from the automotive industry, highlight how innovative efforts to achieve environmental sustainability can generate detrimental environmental and societal impacts. Specifically, the authors identify four sustainable innovation tensions, at the firm level and the value net level. They outline the aggregate economic, social, and ecological sustainability impacts, as well as the critical need for an exhaustive definition of the value net and which factors influence coopetition in sustainability efforts.

Keywords

Case study, Coopetition, Networks, Sustainable innovation, Value net,

1. Introduction

Sustainable innovation (SI) refers to "a process where sustainability considerations (environmental, social, and financial) are integrated into company systems from idea generation through to research and development (R&D) and commercialization. This applies to products, services and technologies, as well as to new business and organizational models" (Charter & Clark, 2007, p. 9). It evokes institutional change by modifying the dynamics of existing organizational fields or creating new ones (Delmas & Toffel, 2004), with the goal of achieving sustainable development, "reducing the impacts of production modes on the environment, enhancing nature's resilience to environmental pressures, or achieving a more efficient and responsible use of natural resources" (Delmas & Pekovic, 2018, p. 1072), and fostering positive social changes to the status quo (Pfitzer, Bockstette, & Stamp, 2013).

Yet as is true of any innovation, SI entails complex processes and uncertain motivations, goals, and outcomes (Silvestre & Ţîrcă, 2018), which threaten the risk of negative impacts (Rogers, 2010). Also similar to any type of innovation (Bledow et al., 2009; Mick & Fournier, 1998), SI might evoke tensions (Hahn et al., 2015; Vallaster et al., 2021; Van der Byl & Slawinski, 2015), clashes of ideas, and even discomfort (Stohl & Cheney, 2001), especially in global, fast paced settings that require involvement by varied business and societal actors. In general, sustainability cannot be managed by individual actors alone (Kiron et al., 2012; Schaltegger et al., 2013b, 2016), because solutions to sustainability-related challenges require cooperation within firms (e.g., across business functions) and among multiple actors (e.g., firms, industry bodies, regulatory authorities, nonprofit organizations), which participate in the value network (depending on the particular literature, the terms 'value net' and 'value network' are used) or broader society (Schaltegger et al. 2013b, 2016). These different actors that collaborate to achieve SI might compete too (Kiron et al., 2012; Peloza & Falkenberg, 2009). For example, smart grids combine electricity and IT networks and support the introduction of renewable energy sources, so they require intensive collaboration by university labs, governmental bodies, and users, as well as direct competitors that must share crucial information and resources to create the products and markets for them. Those actors later compete for market share when the market comes into being (Planko et al., 2016; for a wine industry example, see also Christ et al., 2017).

The simultaneous pursuit of cooperation and competition between actors in a value network is coopetition (Afuah, 2004; Bengtsson & Kock, 2000; Brandenburger & Nalebuff, 1996), and it offers a range of advantages. Most research highlights the economic outcomes of coopetition for the firms involved (Manzhynski & Figge, 2020), including enhanced new product development processes, market positions, financial performance, knowledge sharing, production efficiency, and business model innovation (e.g., Bouncken et al., 2018, 2020; Garri, in press; Ritala et al., 2014). Yet coopetition also gives rise to tensions that may undermine relationships (Fang et al., 2011; Fernandez et al., 2014; Raza-Ullah et al., 2014). In a sustainability setting, companies already face tensions, because their simultaneous pursuit of economic, environmental, and societal goals is challenging (Hahn et al., 2015; Vallaster et al., in press; Van der Byl & Slawinski, 2015). Therefore, some researchers question the benefits of coopetition for sustainability and contend that its competitive features might raise further obstacles to achieving sustainability objectives, in the form of additional conflicts, opportunistic behaviors, and power imbalances (Hahn & Pinkse, 2014; Touboulic et al., 2014)—that is, features that reflect the dark side of business relations conducted among SI actors. Despite some relevant contributions though (Christ et al., 2017; Planko et al., 2019; Stadtler, 2018; Volschenk et al., 2016), empirical research on coopetition for sustainability remains rare and uncertain regarding the interrelated economic, social, and environmental outcomes, at both firm and societal levels (Manzhynski & Figge 2020).

With the assertion that coopetition contributes to sustainability only if it offers benefits at the societal level, and in an effort to address calls for a more systematic review of possible outcomes (Manzhynski & Figge 2020), we undertake a qualitative analysis of how sustainability-oriented innovative efforts in the automotive industry might generate competitive and collaborative tensions among actors within a value net and then threaten detrimental effects for both participating firms in the value net and for society. We also propose an overarching framework in Figure 1 that identifies key prerequisites of positive economic, social, and environmental outcomes at both firm and societal levels.

In doing so, we make three main contributions to existing literature. First, we investigate coopetition strategies in an SI context (Christ et al. 2017; Manzhynski & Figge, 2020), and explore the tensions between competition and cooperation when striving toward sustainability, at firm and societal levels (Schaltegger et al., 2013a). As we illustrate, coopetition for SI involves tensions on four dimensions: *value generation, temporal articulation*, *relational evolution*, and *knowledge circulation*. We thus offer empirical contributions to research into the tensions caused by coopetition (Fernandez et al. 2014), which represent a dark side of business relations among SI actors, such that this study helps illustrate the relevant dangers from a societal perspective. Second, we study power imbalances in business-to-business relationship networks, not just dyads (Brito & Miguel, 2017; Reimann & Ketchen 2017), which reveals that when SI alters relational power differences and dependence in networks, the actors' attitudes toward competing and cooperating change too. The power imbalances among actors in broad networks, such as those due to economic resources or market alternative, affect SI processes and outcomes in turn (Touboulic et al., 2014). This consideration helps clarify the influences of various tensions, goals, and interests on SI outcomes and their potential dark sides. Third, practitioners can use these findings to predict the likely outcomes of their coopetitive relationships for SI and find ways to resolve tensions to attain win–win situations, from both firm and societal perspectives.

2. Coopetition tensions

Coopetition combines the dual, contradictory logics of competition and cooperation (Bengtsson & Kock, 2014; Raza-Ullah et al., 2014), and Gnyawali et al. (2016) argue that such a juxtaposition leads to dualities and contradictions that characterize coopetition. For example, the duality of value creation versus value appropriation makes it difficult to cooperate with competitors to create value while simultaneously competing to seize the maximum share of economic value created. The parties also experience the dual need to share knowledge for joint value generation while protecting their core competencies, proprietary knowledge, and resources to realize more private benefits (Bengtsson et al., 2016). Firms might pursue temporal or spatial separation but still seek to integrate their perspectives to reconcile incompatibilities. Another duality refers to bridging versus bonding, as manifested in the choice to work closely with partners to create value but avoid becoming so close that it creates vulnerability. Finally, coopeting firms may have divergent economic interests; different strategies related to their prior commitments, future priorities, and time orientation (long- versus short-term orientation); and unique organizational identities.

The juxtaposition of such contradictory elements creates tensions (Raza-Ullah et al., 2014), most of which relate to roles, knowledge, power, dependence, or opportunism (Tidström, 2014), as part of the dark side of relations among SI actors. In their review, Planko et al. (2019) establish that companies working with competitors risk copycat behaviors, such that competitors might take their ideas or innovations, as well as unintentional leakages of confidential information. Coopeting companies also might not agree on the goals to be achieved, and one party might be acting primarily out of self-interest. They need to agree on the time and effort each party will contribute too. As a salient concern, such efforts could lead to a loss of decision-making rights or power and an increase in their dependency. The returns on investment are not always equivalent either. Finally, Planko et al. (2019) highlight the risks of becoming less innovative, due to group thinking effects, and the potential failure of the coopetition effort due to coordination difficulties.

3. Coopetition for sustainable innovation

Innovation with the potential to contribute to more sustainable production and consumption systems (Smith et al., 2014) also can improve “sustainability performance, where such performance includes ecological, economic, and social criteria” (Boons et al., 2013, 2). Specifically, economic sustainability refers to the extent to which SI actors have “cash flow sufficient to ensure liquidity while producing a persistent above average return to their shareholders”; ecological sustainability requires that SI actors “use only natural resources that are consumed at a rate below the natural reproduction, or at a rate below the development of substitutes, … do not cause emissions that accumulate in the environment at a rate beyond the capacity of the natural system to absorb and assimilate these emissions, … do not engage in activity that degrades eco-system services”; and social sustainability indicates that SI actors “operate by increasing the human capital of individual partners as well as furthering the societal capital of these communities, … manage social capital in such a way that stakeholders can understand its motivations and can broadly agree with the company’s value system” (Dyllick & Hockerts, 2002, pp. 133-134).

In addition to promising to transform business and offer entrepreneurial opportunities (Larson, 2000), SI can be a source of societal change (Bocken et al., 2019; Boons et al., 2013). Schaltegger et al. (2013a) propose that coopetitive strategies can be relevant for enhancing businesses’ economic, social, and environmental performance, though their viability in sustainability contexts is still unclear (Christ et al., 2017; Limoubpratum et al., 2015). A few studies of coopetition for sustainability discuss outcomes at a general level or for specific aspects (e.g., logistics, green product innovation, procurement; for a review, see Manzhynski & Figge, 2020). But such a focus can exclude negative impacts on various dimensions; for example, greater eco-efficiency might not decrease overall uses of a resource, if the improvement leads to greater demand (Dyllick & Hockerts, 2002). Because SI seeks economic, environmental, and social goals, the need to balance positive and negative outcomes is inherent (Manzhynski & Figge, 2020).

With a systematic research effort, Manzhynski and Figge (2020) explore possible outcomes of coopetition for sustainability for a focal firm and a coopeting firm, as well as for resource uses and society (i.e., joint environmental and economic outcomes for all involved firms). They identify 51 different pathways to distinct outcomes, only 1 of which creates all positive outcomes for all actors. The other 50 feature mixed positive and negative outcomes and trade-offs that likely constitute sources of tension. In turn, they call for a broader view of coopetition that uses outcomes for the value net as the unit of analysis. That is, coopetition efforts often go beyond between direct competitors to encompass a broad value net of customers, suppliers, competitors, and complementors that simultaneously cooperate and compete, in vertical and horizontal relationships (Bengtsson & Kock, 2014; Brandenburger & Nalebuff, 1996). For SI, such a broad definition may be more relevant, because systematic change demands cross-sector collaborations of firms, suppliers, competitors, customers, universities, regulatory authorities, and so forth (Melander, 2017). Furthermore, the scope and impact of ecological and social issues and outcomes extend beyond any one dyad or industry (Christ et al., 2017; Planko et al., 2019). A positive outcome at the firm level might not translate into a positive outcome at the societal level; for example, environmental pollution and water use pertain to shared resources (Bowen et al., 2018), so a single firm's or dyad's actions might undermine the outcomes for all other firms and the society at large.

The tensions triggered by coopetition for SI in the value net remain insufficiently studied though, especially with empirical research. Whether and how the tensions might undermine or hinder actual or perceived benefits of SI has not been addressed. Through this investigation of how SI might generate competitive and collaborative tensions among actors in the value net and how these tensions in turn affect sustainability-related outcomes, we derive Figure 1, as an integrated overview of our findings and an overarching framework that frames the remainder of this article. On the right-hand side, it depicts ecological, economic, and social sustainability goals to be achieved (natural, social, and business cases); in its center, we include the tensions that we identified in our field research (discussed in the next section) and that affect the attainment of sustainability goals; and then on the left, the figure reflects the need to define components of the coopetition "game" carefully at the onset of any SI, to avoid tensions. We explicate the relevance and importance of these components further in the General Discussion section.

4. Methodology

Our research context refers to the automotive industry, which represents a major contributor to many national economies but also to environmental air quality, climate change, and human health concerns (Abro et al., 2019; Mamalis, Spentzas, & Mamali, 2013). Global growth in vehicle ownership rates has increased demand for fuel and materials (e.g., metals, glass, rubber, special fibers) and air pollution (Zhang et al., 2021). In turn, growing legal and societal pressures demand that the automotive industry become more sustainability oriented (Khodier et al., 2018; Kushwaha & Sharma, 2016; Mayyas et al., 2012; Schöggl et al., 2017). Actors in this industry already are innovative (Williams, 2007), such that different SI could shape the industry's future to achieve positive environmental outcomes (Calza et al., 2017; Wolff et al., 2020) and new mobility concepts (Cassetta et al., 2017), including electric vehicles (Moradi & Vagnoni, 2018), servitized mobility solutions (Naor et al., 2018), and autonomous cars (Yun et al., 2019).

We investigate two main categories of SI development efforts. First, developments of alternative, sustainable motorization tend to focus on electric vehicles (EV), which arguably may lower greenhouse gas emissions and air pollution, as well as increase jobs (Günther et al., 2015). Second, the development of connected or autonomous vehicles (CAV) promises safer, more enjoyable rides for passengers. They also might help secure the lasting survival of the automotive industry, if it shifts to provide smart, more eco-efficient transportation systems in sustainable cities (Chehri & Mouftah, 2019).

4.1. Data collection

Our qualitative, multiple case study approach generates richer theory than a single case study (Eisenhardt, 1989) and enables us to probe informants' knowledge and thinking in a topic that is not widely researched (La Rocca et al., 2017). Gioia et al. (2013, p. 19) call for qualitative research with semi-structured interviews to obtain "both retrospective and real-time accounts by those people experiencing the phenomenon of theoretical interest." In our individual, in-depth interviews, we gathered insights into marketing and management practices and sustainability concerns about EV and CAV. The informants are all members of an automotive industry value network, whom we selected according to a judgmental sampling strategy (Patton, 2004), to acknowledge that product innovation in an industry can spur tensions among stakeholders at different levels of the value net. We sought to maximize diversity among informants in terms of their positions and experiences within and around the automotive industry. They occupy different positions, focused on everything from material processing to end-of-life options, as the description in Table 1 reveals. In addition to

Table 1. Sample

SECTOR	ORGANIZATION	FUNCTION OR TITLE	INTERVIEW	LENGTH
Material processing	Automotive suppliers (tires)	Brands Marketing Director Europe	1	00 :52
	Automotive suppliers (glass)	Advanced design manager	2	00 :58
	Automotive suppliers (glass)	New Project Manager Europe	3	00 :30
	Automotive suppliers (glass)	Advanced development engineer	4	01 :22
	Electronics supplier	Chief Technology Officer and co-founder	5	00 :46
	IT& connectivity supplier	CEO, co-founder	6	00 :28
Manufacturing	Premium brand	C.A.S.E. implementation manager	7	01 :15
	Mid-range brand	Head of press and corporate communication	8	/
	Low-end brand	Manager brand strategy	9	00 :33
	Premium brand	Sales advisor	10	01 :09
	Premium brand	Industrial engineer	11	01 :46
	Mid-range brand	Aftersales service director	12	01 :24
	Mid-range brand	Digital campaign manager	13	00 :54
Product delivery and customer use	Car sharing company	Senior manager strategy and business development	14	00 :37
	Car sharing company	Marketing and communication manager	15	00 :40
	Leasing company	General manager	16	01 :14
	Leasing company	Sales and Marketing manager	17	00 :53
After-sales services	Independent channel	Garage manager for all types of cars	18	00 :20
	Authorized channel	Worker at a repair shop of low-end brands	19	00 :17
	Authorized channel	Car dealer for low-end brands	20	00 :41
End-of-life	Recycling organization	Director	21	00:46
Automobile federations	National automobile and cycle federation	Communication director & Training	22	01 :35
	Automobile sector and related sectors federation	Legal affairs manager	23	01 :50
Authorities	Mobility and transport national public service	Sustainable mobility advisor	24	01:09
Road assistance	Road assistance company	Senior product manager	25	00:43
Other stakeholders	Press	Journalist	26	00 :57
	Press	Journalist	27	01 :55
	University	Professor, expert: microelectronics	28	00 :42
	University	Professor, expert: electronic	29	01 :15
	European Economic and Social Committee	Advisor, expert: products lifespan and obsolescence	30	00 :26

Regional federation of environmental NGOs	Advisor, expert: mission head “mobility”	31	00 :44

representatives of suppliers to automotive manufacturers; manufacturers of low-range, mid-range, and premium brands; firms that share and lease vehicles; firms that recycle used vehicles; and automotive federations, we included six external informants: two journalists with knowledge of the automotive industry and four experts in microelectronics, mobility, electronics, and product lifespans.

We conducted the interviews in French or in English, mostly face-to-face at the informants' location, to encourage meaningful, consistent perceptions of real-life situations (Wünderlich et al., 2013). Due to the geographically distant location of some informants, we employed remote video techniques for five interviews (King et al., 2018) as a useful replacement (Deakin & Wakefield, 2014); one expert answered our questions in writing. The interviews were recorded and we transcribed verbatim, with the informants' permission. Prior to each interview, we reviewed publicly available secondary data on firms' websites to increase our familiarity with the cases. The interviews took place between January and April 2018. We achieved theoretical saturation after 31 interviews (McCracken, 1988; Patton, 2014).

The semi-structured interview guide consisted of questions related to the informants' experience with the automotive industry, prompts, and follow-ups (McCracken, 1988), separated into three parts. The first part began with broad, grand tour questions (Spradley, 1979) related to the informants' field of expertise, to prompt a first-person narrative and lay the foundations for a confident, informative interview. The second part explored their perceptions of challenges related to SI in the automotive industry and its potential positive and negative effects in the industry, at the actor, value net, and societal levels. Finally, the third part asked informants to reflect on the future of EV and CAV. The interviews lasted between 17 and 115 minutes, with an average of 57 minutes and a total of 28.6 hours. The transcription of all the recorded interviews resulted in 416 single-spaced pages of text.

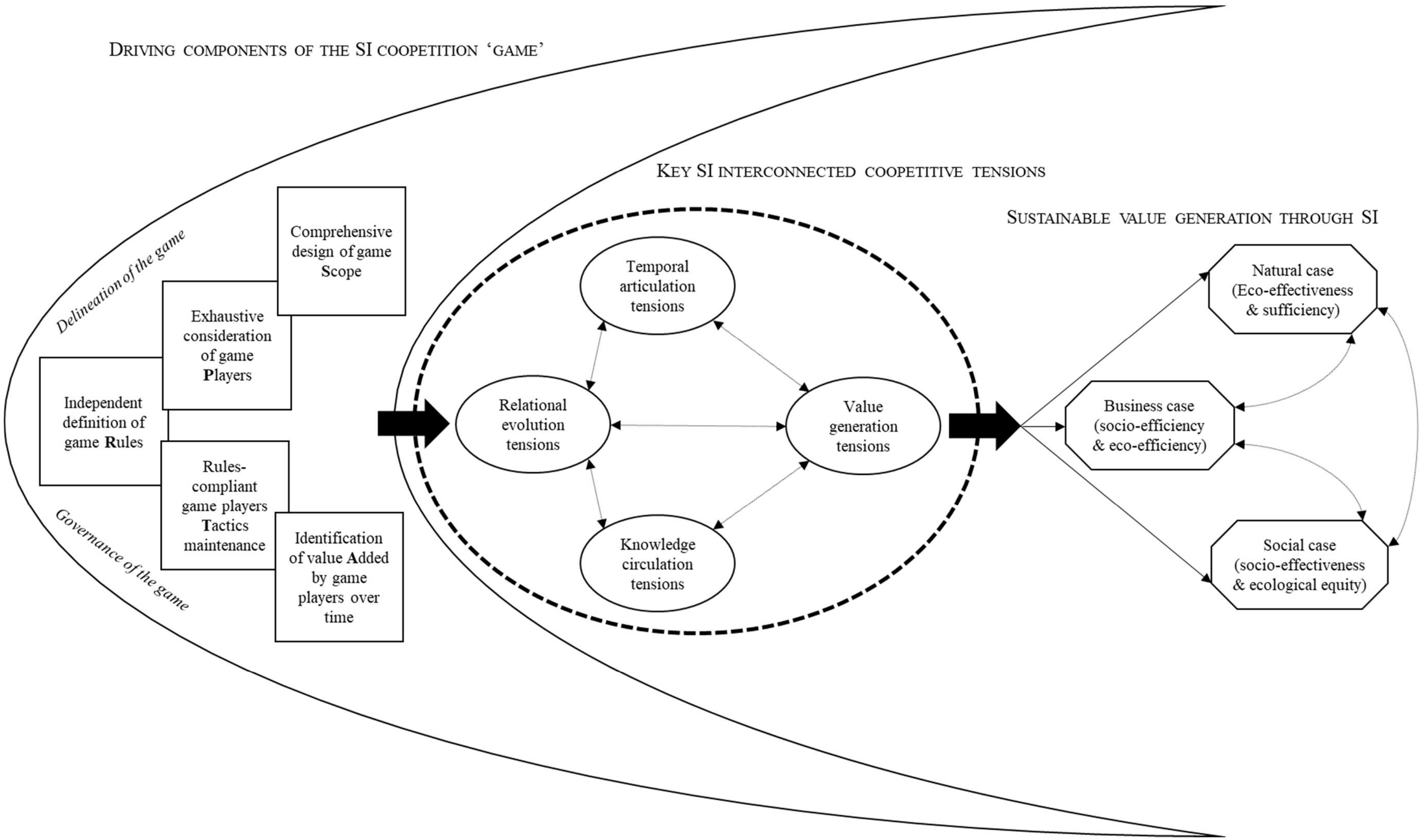
4.2. Data analysis

We used Nvivo to keep track of the data, facilitate coding, and check for relationships. All interviews were carried out by the same researcher. From an analytical perspective, our theory-generative approach involves several phases, during which we progressively increased the level of analytical generalization (Strauss & Corbin, 1998). We first coded the interviews using a predefined code list that we expanded to capture emerging themes. In line with our focus on identifying sustainability issues and tensions activated by SI, and because tensions exist at societal, interorganizational, and intra-organizational levels (Tidström, 2014), we closely analyzed the data to highlight challenges and various outcomes, according to the positions of the interviewees and their organization in the value net (e.g., material processing, manufacturing). Next, we elaborated on theoretical categories through axial coding (Strauss & Corbin, 1998), reassembling the data into categories and subcategories, to enable comparisons of key challenges and outcomes, as well as to delineate SI-related tensions experienced in the value net. Finally, we constructed a storyline by integrating and refining the theory emerging from the data. Throughout the study, we followed Lincoln and Guba's (1985) recommendations to maintain analytical rigor and establish the trustworthiness of the data. We constantly moved among data, themes, and existing literature to ensure the fidelity of the emerging concepts to the data, situate the results according to preexisting knowledge (Baxter & Jack, 2008), and confirm the credibility of our interpretations (Gioia et al., 2013).

5. Findings

Our analysis reveals that coopetition for SI is associated with interconnected tensions (see center of Figure 1) that can be articulated according to four main dimensions of the value net: (1) value generation, (2) temporal articulation, (3) relational evolution, and (4) knowledge circulation.

Figure 1. Coopetition tensions and generating sustainable value through SI



5.1. Value generation

Value generation tensions emerge from actors' common aspirations to generate added sustainable (i.e., social and ecological) value for key stakeholders and broader society, while also pursuing their own, self-centered, economic ambitions. Because it involves the expectations and interests of multiple stakeholders and network actors, sustainable value is a "wicked problem" that evades clear solutions (Dunne, 2010). The underlying assessment anticipates that value gets generated (or impaired) when some resource (e.g., environmental) is used more (or less) efficiently than it would be by an alternative use (Manzhynski, Figge, & Hassel, 2015).

In line with some previous predictions (Manzhynski & Figge, 2020; Smith et al., 2013), we find that coopetition for SI often leads to real or perceived performance-related trade-offs involving the pursuit of sustainable value, which is inherently multidimensional. That is, SI processes evoke tensions because the more efficient use of one resource by the focal or coopting firm may lower the efficiency of its use for every other firm. The result is mixed economic, social, and environmental outcomes for the actors in the value net and the surrounding societal ecosystems.

First, we find contrasts in the economic prospects of SI for value net actors. The progressive rise of EV and CAV arguably might generate long-term positive effects at the societal level (Bissell et al., 2020; Malmgren, 2016). In detail, EV might generate fewer emissions over their lifespan (Casals et al., 2016), be more reliable than thermal vehicles, and have a longer life expectancy (as long as the batteries are changed regularly) (Gandoman et al., 2019); CAV can increase driving efficiency, reduce maintenance and bodywork demands, and lower injury cases and accidents (Thomopoulos & Givoni, 2015; Zhu et al., 2020). Both versions also might lower the costs of mobility for users (Bösch et al., 2018; Mitropoulos et al., 2017). Yet the technological developments that support their growth and mobility performance also increase pressures on other actors in the value net to maintain their economic performance and proficiency. That is, some actors benefit economically from the rise of products and services driven by this SI (e.g., providers increase activity and employment, fleet connectivity solution providers enter the market, car sharing companies are expanding), but others (e.g., car manufacturers) experience volume pressures, and still others face obsolescence of their product offers. Activities provided by some sales and aftersales actors also may shrink (e.g., traditional car maintenance), and taxi drivers and companies even might disappear. As one interviewee notes, “This is one of our biggest concerns at this moment. How will we make all these dealerships, these business units, how will we make them profitable if we do electric cars?” (I12).

Second, SI processes and outcomes drive intra-organizational tensions, with mixed implications for SI at the value net level for each organizational actor, because the economic, environmental, and social outcomes for actors are inconsistent (Manzhynski & Figge, 2020). According to Hahn and Pinkse (2014), opportunistic behaviors do not necessarily disappear when actors have the collective ability to improve their sustainability. Each actor must make strategic and tactical choices, including whether to embrace SI technologies, and those decisions then affect the balance between shared (sustainable) value creation and self-centered (economic) value appropriation. For example, car manufacturers must develop new technologies to support EVs’ and CAVs’ environmental performance. Yet, in their economic model, margins are low, and the profitability earned through aftersales activities is threatened by such new technologies. Thus, many car manufacturers have responded by offering only high-end, expensive EV and CAV models, to maximize their profits. The resulting models may be unable to achieve eco- and socio-efficiency, which depend on dimensions such as vehicle weight and the type of battery (Berjoza & Jurgena, 2017). The energy consumed per distance travelled is almost twice as high for higher capacity, heavier vehicles (e.g., Kia Soul, Tesla Model S) than for vehicles with a lower gross weight (e.g., Renault Twizy, Tazzari Zero). Moreover, EV accounts for only a marginal proportion of the global passenger fleet, and price appears to be the main short-term determinant of mass adoption (de Rubens, 2019). Persistent high prices mean that the adopters of both low- and high-end EV are high-income earners (Hardman et al., 2016), whereas low-income consumers are de facto excluded. According to one informant, EV target

> A whole segment of the population, relatively affluent people, enjoying fashionable trends … [who] will switch to electric vehicles in the foreseeable future for the sake of buying the most recent model as the offer will keep developing primarily in the high-end [segment] … and now we must see how the rest of the population will or will not follow (I31).

In turn, this SI cannot achieve its full positive impact potential at the macro level.

Policymakers face similar tensions. Policies that might foster mainstream adoption (e.g., support for R&D, investments in charging infrastructure and service equipment, vehicle tax credits) ultimately might diminish public authorities' capacity to leverage economic resources (Green et al., 2014), because if

> Electric cars no longer consume fuel, there is no more revenue for the state … but the Belgian state earns roughly 5 billion per year in excise duties and VAT on fuel. So, … I believe that to give themselves a good environmental conscience, authorities promote electric cars but consciously know that they can never be the car of replacement of the thermal car (I27).

The resolution (or not) of tensions at the actor level thus may hamper (or not) the achievement of SI objectives at the societal level.

5.2. Temporal articulation

Temporal articulation refers to tensions that arise because actors in the value net need differentiated positions to benefit from SI in the short term, but they must develop an integrative perspective over time to support the deployment and adoption of the SI in a way that drives sustainable change at the societal level. Similarly, a separation versus integration duality has been suggested as significant in coopetitive processes in general (Gnyawali et al., 2016). In our specific context, many interviewees cited the need for the joint development of resources and capabilities to implement SI and generate positive macro impacts (Rebelo et al., 2016). Integration helps actors satisfy sustainability demands in a coherent, consistent, optimal way. To launch EV and CAV for example, car and equipment manufacturers had to collaborate closely, to ensure the consistency of digital networks and address needs for connectivity. However, these manufacturers also compete to develop key specificities and effective marketing activities. Potential difficulties also emerge due to incompatibilities and problems created by technologies that typically would be approached in a disjointed way. In this context, the actors might respond by “taking out expensive insurance to protect themselves” (I8) from integration-related risks, such as when the parts and software, which belong to or are controlled by different actors, do not align. Such risks and issues increase the level of complexity, which demands an effortful, time-consuming search for solutions, as the following quote highlights:

> I talked to an engineer at GM, involved in the power train design of the cars. She highlighted a problem with the transmission and could see a software solution to fix it. But she couldn’t just set it out for all cars without checking people in fuel economy, people in chassis design, and other engineers and designers for that module as it could affect some of those other components in a different way.… I can’t change something

> without looking at how it's gonna change everything else, and then, it introduces some sort of security issues and other problems (I26).

Shorter-term competitive requirements also can undermine longer-term goals to achieve truly sustainable outcomes and harmonize the activities and objectives pursued by the different actors in the value net. That is, short-run competitive requirements and market-related pressures often disrupt the development of systemic approaches (Lopez-Arboleda et al., 2020) and industrial metabolism perspectives (Ayres, 1994) to generate sustainable value. Even "sustainable" innovation might become ecologically questionable in the long run (Dyllick & Hockerts, 2002). Notably, the promotion of EV by government and companies reflects profound incompatibilities in their objectives: the development of extractive industries and availability of raw materials on one hand versus the lack of consideration of end-of-life solutions or battery recycling on the other. So as one interviewee asked, "Is it green or not? Do we have the right raw materials, whether for batteries or to produce renewable energy? What about the recycling facilities which for the moment do not exist?" (I24). Other short-term issues related to the long-term development of EV and CAV include limited resource availability, such as lithium (Egbue & Long, 2012; Vikström et al., 2013), "the most widely used component in the production of car batteries.… If the 85 million new cars were all electric, we would have no more lithium readily available in a few years.… In addition today, there are no reliable and exploited industrial methods of recycling lithium-ion" (I27). Thus more long-term integration in the broad value network might enable the development of alternative paths and more impactful SI at the macro level. Car batteries with reduced charging capacity, no longer suitable for use in vehicles, might

> be used at home or elsewhere, or be used by people who will connect batteries in series to store energy and serve as power supply locally.… The car batteries are not only used to keep your car moving, but can also be used at home for other things, as a

> source of energy. So, the car becomes somewhat, part, of your home energy system (I23).

From a more integrative perspective, recyclable products and components enhance the role of end-of-life actors, in an effort to increase the efficiency of resources use (Chertow, 2007). Some of these actors anticipate receiving more vehicles as CAV expand in number, such that "We hope for a system in which the connected car can only be disconnected in an approved center" (I21). Similarly, for shared cars, "the sharing systems and platforms [must] apply end-of-life vehicle legislation, so that out-of-use shared cars are ending in authorized centers" (I21).

To address short-term, market-related pressures and foster better relationships (Niesten et al., 2017), the role of the institutional environment (e.g., environmental laws, regulations) and infrastructure is key. Legislation that mandates end-of-life policies for vehicles represents one example; authorities also might seek to stimulate demand for the SI (e.g., tax credits, quotas). In terms of infrastructure, our interviewees suggest that authorities are critical to effective long-term development. Policies that favor dense, elaborated networks of charging stations and fast, reliable connectivity networks are required, but efforts and investments in many institutional environments remain limited and can contribute to feed temporal articulation tensions, such as "in cities, there should be easy possibilities to charge cars in parking lots. That would require strong legislative and policy commitments and I simply don't think that the Belgian government is really there yet" (I9). According to prior technology diffusion models (e.g., Meyer & Winebrake, 2009), temporal articulation tensions create a classic "chicken-and-egg" problem: People do not adopt the SI without adequate SI infrastructure, but investments in infrastructure remain low until SI is more massively adopted.

5.3. Relational evolution

Relational evolution tensions appear because actors in the value network can derive novel resources and opportunities from the SI, but when they depend on those innovations to perform tasks, they might lose some control or influence. In particular, for users, CAV offer augmented comfort and security (e.g., automatic braking systems, pedestrian detection), but if the automation technologies fail, they undermine users' sense of safety, while also reducing their sense of autonomy (André et al., 2018). The advanced comfort and security features increase both users' dependence on the vehicle's abilities and their vulnerability to product failures. Similarly, with their remote diagnosis capability, CAV facilitate diagnoses of car-related issues, so users can better anticipate potential troubles. Yet the complex electronics and IT components required to support this capability leave most users unable to perform self-repair, triggering novel relational dependences: "People today don't know how to fix it themselves. You need devices! An electric car, not everyone can touch it because of the car 5000 kilowatt loads" (I10). Another such tension arises because CAV foster knowledge transparency (e.g., data access, notifications), so users "no longer necessarily depend on the vehicle manufacturer" and instead rely on their own ability "to regulate the costs, make maintenance and upkeep costs cheaper" (I6). Yet at the same time, CAV increase opacity for users, due to the producers' perceived opportunities to engage in information manipulation, such as issuing more frequent, automatic requests to replace components:

> People can't fix [issues] themselves…. Sometimes it's done on purpose, as cars are so reliable. If we don't do it on purpose, people don't come back. You have to know one thing: the fact is that in a dealership, selling a car is not a winner. It's practically a loser. What pays off in a dealership is the aftermarket (I10).

For car manufacturers and other actors, such concerns alter the power balance in coopetitive relationships (Tidström, 2014). The threats to manufacturers' bottom line, due to the greater reliability of EV and CAV, exert more pressure on sales volume considerations and make after-sales margins more critical. Manufacturers thus adopt proactive strategies to integrate and exploit the cooperative potential linked to after-sales services, which may imply "the ever-greater importance of having your vehicle serviced or even simply monitored by an official agency of the brand, the only one that has the information, the working method … not the case for an independent garage or a chain that only does maintenance" (I27). For after-sales actors, such SI-associated tensions are reminiscent of the technology paradox: "The same technology that simplifies life by providing more functions in a device also complicates life by making the device harder to learn, harder to use" (Norman, 1998: 31), and perhaps harder to repair. Thus, even if an issue with "an electric car is more easily detectable [cf. conventional cars] with all the computerized tools that can be put on the car" (I11), those computerized tools also usurp human competence, encourage human dependence, and degrade the environments (Mick & Fournier, 1998), especially if a particular actor (e.g., manufacturer) exercises relational power over another (e.g., independent mechanic) by controlling resources essential to the activity.

5.4. Knowledge circulation

Finally, knowledge circulation tensions refer to the need to share data, knowledge, and know-how with other value net actors versus the need to protect and exploit key data, knowledge, and know-how. Data, knowledge, and know-how are sources of competitive advantage, but sharing them is important to generate broader value (Chin et al., 2008) and enhance environmental and social performance (Oinonen et al., 2018). Our interviewees stress the importance of sharing knowledge for the benefit of different levels of the value net. Manufacturers, suppliers, and subcontractors must exchange data and other knowledge-related resources to develop the services and products. But they also acknowledge the risk of leakages, such that data and knowledge sharing is limited. In the relationships that link manufacturers, leasing companies, and connectivity providers,

> There are quite a few car brands that collect data from the cars and that can even contact the customer to say ‘be careful, you need maintenance’ or ‘there is something wrong with your car’ and that bothers garages in the first place, but also the leasing sector. Because leasing companies don't like manufacturers to have a direct relationship with the end driver. The leasing company owns the car and they don't want to be confronted with the fact that the manufacturer, together with the driver, have decided that they are going to replace whatever in the car…. So, they really want to keep some separation and to have access to the data that comes from the cars (I16).

Similar issues complicate the relationships of independent after-sales actors or road assistance providers with manufacturers: “We face breakdowns where we are limited to a certain point: we can see what the error codes are, but some are encrypted [protected by the brand] so we don't know how to go any further." (I18). Institutional actors might help tackle such concerns by mandating that vehicle-generated data are available to third-party service providers, in a way that protects the user’s personal data, but even in that case, the data and knowledge acquisition efforts required might remain too expensive for third-party services. Therefore, knowledge/data protection entails many changes in the network and may have detrimental outcomes for some actors, such as independent after-sales mechanics, that do not have access to the technology protected (at a high cost) by manufacturers, as well as increased market specialization (in one brand versus multiple brands).

Finally, data and knowledge sharing (or leaking) may undermine some desirable outcomes of SI. For example, data collected by CAV might be accessed by interested third parties, “Because if you are someone who drives very sportily, that may interest your insurer of course" (I18). Yet without sharing such data, users cannot access mutually beneficial results, such as an increased ability to plan maintenance and repairs. The interviewees also predict substantial changes to car servicing models due to the rise of CAVs: “Do we need a network of 3000 gas stations in Belgium? I don't think so.… Does an [original equipment manufacturer] really need 50 dealerships to do maintenance? Big question!" (I17). To achieve such changes, the actors need to share data, including allowing the SI "do the math" (e.g., estimate the level of fuel needed for a trip, plotting when and where to recharge).

6. General discussion

As a contribution to the ongoing debate around uncertain outcomes of SI (Silvestre & Ţîrcă, 2018), our study proposes a more nuanced perspective on the actual sustainability of various efforts, by assessing their impacts on actors at different levels of the value net and adopting a system-oriented perspective. In particular, we take a coopetition perspective on the value net (Brandenburger & Nalebuff, 1996) to gain deeper understanding of how coopetition for sustainability, as in the context of automotive industry SI, might deliver economic, social, and environmental outcomes at firm and societal levels. As we show, these SI efforts generate tensions, which we articulate around four main dimensions: (1) value generation, (2) temporal articulation, (3) relational evolution, and (4) knowledge circulation. Value generation tensions emerge from value net actors' common aspirations to generate added societal and ecological value, but also their self-centered economic ambitions. Temporal articulation tensions relate to the need for actors to separate themselves from competitors to remain distinctive and benefit from the SI but also to ensure integration in the longer term so that they can achieve broader sustainability goals at the macro level. Relational evolution tensions originate from unequal access to the benefits created by the novel opportunities the SI offers. Finally, knowledge circulation tensions emerge due to the need for actors to share data, knowledge, and know-how while also protecting their own critical data, knowledge, and know-how.

These interconnected tensions in turn can mitigate the positive sustainability-related impacts of specific SI efforts (see right side of Figure 1). In assessing the impacts of these identified tensions, we consider economic, ecological, and social sustainability, as well as whether the final outcomes go beyond merely eco- or socio-efficiency (i.e., the business case). According to our findings, actors in the value net must move beyond the business case and consider the natural case for corporate sustainability, by focusing on eco-effectiveness and sufficiency, as well as its social case, with a focus on socio-effectiveness and ecological equity (Dyllick & Hockerts, 2002). Eco-effectiveness is an absolute improvement in the total impact of meeting consumers' demands on ecological systems (Braungart et al., 2007; Figge & Hahn, 2004); socio-effectiveness implies the reduction of the absolute level of harmful social impacts, relative to expectations, and the generation of positive social benefits (Schaltegger & Buritt, 2005; Young & Tilley, 2006). For example, electrical cars generate fewer emissions than fuel cars, but they rely on a scarce, non-renewable resource (lithium), a new infrastructure (charging stations), and different maintenance equipment. The previous infrastructure and equipment thus may become obsolete and require disposal, which could produce an aggregated negative impact on the environment, aggravated by the short lifespan of the batteries and the fragility of the power grid. Furthermore, EV rely on new technologies that require less labor, which may mean the replacement of low skilled workers in the value net and an aggregate negative social impact. These potential negative social and ecological impacts intensify with the shift in production from smaller, lower range electrical cars to heavier, larger EV, due to profitability concerns (economic sustainability). Similar arguments hold for CAV, which might boost driving efficiency and provide environmental gains but also require new computer-aided equipment and infrastructure (e.g., connectivity networks), with negative impacts on the environment (e.g., obsolete equipment). If CAVs reduce the number of car accidents and injuries, they might require less maintenance and repair, leading again to job losses among low-skilled labor forces.

We also posit that SI in the automotive industry might cause harm to future generations and jeopardize ecological equity (Dyllick & Hockerts, 2002), because they likely will have to confront increased waste (obsolete equipment and infrastructure), growing pressure on scarce resources that might encourage mining activities with detrimental environmental and social impacts, and impoverished labor skills that could increase the wealth gap. This latter divide also might be reinforced by limited societal access to EV among poorer segments, especially if fuel alternatives no longer exist or are heavily taxed. Finally, actors in the automotive value net have not adopted radical new approaches to sustainability, such as sufficiency, which tries to reduce absolute demand by mitigating consumption (Bocken & Short, 2016). We also did not encounter any mentions of it in our interviews.

To engage in coopetition that truly leads to SI, we turn to the coopetition game described by Brandenburger and Nalebuff (1996), which includes five components: Players, Value, Rules, Tactics, and Scope (see left side of Figure 1). A careful definition of these game components at the onset of any SI effort might help ensure better performance. To start, the comprehensive value net must include all parties that might be affected, in the short and long term, by the SI (see also Zhou & Mi, 2017), reflecting the players and scope components. Our findings show that players directly involved in the short-term game tend to be prioritized over those that might enter the game later or only indirectly. As Brandenburger and Nalebuff (1996, p. 255) put it, “There is always a LARGER game,” and the crucial challenge is to define it, to avoid an overly narrow scope. To identify the added value each player can introduce into the game (e.g., assets, skills, influence), it also is important to work out the rules of the game. For SI, we argue that the rules should ensure the equity of gains (value), shared among players, and also the equal importance of goals associated with natural, social, and business cases. Rules to ensure the greater good should be drafted by a neutral, independent party to avoid any conflict of interest. This party should possess multidisciplinary expertise and equitably consider multiple angles on SI. Making the rules explicit is a first step toward enforcing them. That is, setting rules in coopetition for the greater good is a pertinent societal governance mechanism.

Our findings and the SI coopetition-related tensions we identify suggest that the natural and social cases are, at most, implicit goals for SI in the automotive industry, not clear objectives to achieve. Without impartial rules, the game is unlikely to channel players' self-interest toward the greater good, attain natural and social cases, or move beyond the economic case. In other words, Adam Smith's "invisible hand" is not powerful enough to attain such objectives. Similarly, Hahn and Pinkse (2014) contend that the achievement of societal objectives in cross-sector partnerships of rival firms depends on whether competitive forces at the firm level align with these objectives. Ma et al. (2017) also call for societal governance mechanisms in social responsibility megaprojects, reflecting the well-being of wider society.

The tactics are up to each party to choose freely, as long as they are in compliance with the rules of the game. No attempt should be made to change the rules for their own interest, at the expense of the rest of the value net (e.g., bribery, lobbying, corruption more generally; Lin et al., 2017). Full disclosure of all ethical considerations also must be timely and widespread (Lin et al., 2017; Ma et al., 2017). Such precautions can help mitigate unequal distributions of value among the parties involved in the SI, which otherwise might occur due to the parties' power asymmetry (Reimann & Ketchen, 2017). Power asymmetry largely determines how generated value gets distributed (Crook & Combs, 2007), because the more powerful party uses its power to change the game for its own benefit. Management literature even calls on parties to "deploy their power to extract the best possible terms and conditions" (Crook et al., 2017, p. 10) and promises that "stronger partners have historically avoided constraint mitigation mechanisms" (Crook et al., 2017, p. 13). But to attain positive societal outcomes, such power-based tactics should be constrained and regulated.

The integrated overview of our findings about the tensions (Figure 1) presents their implications for coopetition for SI. It highlights the importance of considering a comprehensive set of performance indicators related to the business, natural, and social cases for SI, as well as the need to define different components of the coopetition "game" with care (delineation of the game and governance mechanisms).

7. Conclusions

With this article, we contribute to research into SI and coopetition strategies (Christ et al. 2017; Manzhynski & Figge, 2020) by identifying four broad tensions between competitive strategy and cooperation in striving toward sustainability, at the firm and societal levels. In this sense, we add to the growing body of empirical research on tensions caused by coopetition (Fernandez et al. 2014). It is paramount for SI to be encouraged. However, if not properly acknowledged and anticipated, the identified tensions might jeopardize the sustainability and success of any SI and act as a deterrent for new SIs. Therefore, it also is vital that firms innovate wisely, by accurately and thoughtfully delineating the "game" and its governance mechanisms. Specifically, we emphasize the importance of clearly, transparently identifying components of the coopetition game for SI and defining them comprehensively, spanning both the vast array of outcomes and the temporal horizon. Furthermore, we expand considerations of the importance of collaboration for value creation, by moving past the dyad to address conflicts and power asymmetries, or the dark side of coopetition relations, in the broader value net (Brito & Miguel, 2017; Foerstl et al., 2017; Reimann & Ketchen 2017). Our findings emphasize the need for a more holistic view that addresses the broad network of relationships involved in the SI and highlights the impact of tensions caused by power asymmetries and conflicting interests on societal outcomes. In turn, we offer insights for practice and policy. In identifying predominant tensions that arise in coopetition for SI, we highlight the need to take a truly holistic approach (to scope and time horizon) to SI initiatives and establish clear, impartial governance mechanisms (i.e., rules that guarantee positive outcomes for all parties and society at large).

Even if our empirical study focused exclusively on the automotive industry, the overarching framework in Figure 1 reasonably should apply to a vast variety of SIs in other contexts, as long as they are characterized by coopetition and cooperation among broad sets of actors. For example, rising demand for absorbent hygienic products (e.g., diapers, sanitary pads) has increased the need for natural resources, the emission of pollutants, and the generation of waste, and furthermore, waste management for such products is extremely challenging (Perez et al., 2020). In this industrial context, different actors are needed to solve the various SI issues at hand: municipalities that can build the infrastructure for waste collection, sorting, and treatment; actors that figure out how to transform plastic waste into chemical feedstock; other actors that supply sustainable raw materials such as biomass; and fast-moving consumer goods firms that devote efforts to developing new product concepts. In addition, whereas we focus on product-level SI, the interplay of product and business model innovations represents a compelling notion for further research too (Chesbrough, 2010). Usage-oriented business model innovations (Zott & Amit, 2002), such as car sharing, likely provide relevant and interesting settings for applying our SI framework for example.

Further research also might suggest ways to cope with or manage the identified tensions, to guide managers and policy makers in their attempts to achieve societally positive outcomes. Scholars have discussed corporate governance in business management and public governance in public administration and political science (Ma et al., 2017). However, more studies are needed to conceptualize options for governing SI projects, which involve heterogeneous stakeholders from the business world, government, and society at large, all of which are competing and collaborating, in the present time and in the future, to attain positive results for the business, social, and natural cases. To clarify and gain deeper understanding of the value generation tensions that are central to our analysis and framework, we suggest that continued research efforts take a more granular approach that can delineate the relational dynamics underlying multi-actor, network-level value creation, as well as the capture and destruction processes at play in sustainable innovation efforts. Finally, along similar lines, we suggest more research into optimal levels of power for coopetition of SI (see also Foerstl et al., 2017). For some forms of the SI, thoughtful uses of power even might contribute to more positive outcomes (Reimann & Ketchen, 2017).

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Author Vitae

Pauline Munten

Pauline Munten, Ph.D., is a teaching assistant at Université catholique de Louvain (UCLouvain), Belgium. She also holds a master's degree in marketing from the University of Namur, Belgium. Her research focuses on product obsolescence, consumer behavior, and sustainable marketing; her dissertation investigates solutions to reduce obsolescence and its resulting environmental consequences, including the role of product durability or reparability information. She has presented her research at international conferences, including the annual conference for the European Marketing Academy, Academy of Marketing Science World Marketing Congress, the Monaco Symposium on Luxury, and the Business and Society Seminar.

Joëlle Vanhamme

Joëlle Vanhamme, Ph.D., is Professor of Marketing at EDHEC Business School. Prior to joining EDHEC, Professor Vanhamme was faculty member at Rotterdam School of Management and IESEG School of Management. She received her doctorate from the Catholic University of Louvain (Louvain School of Management, 2002) and her accreditation to supervise research (French habilitation qualification, 2012) from the University of Bourgogne. Her research has appeared in top-ranking journals such as *California Management Review, International Journal of Research in Marketing, Journal of Business Ethics, Journal of Retailing*, *Marketing Letters,* and *Organization Studies*. One of her core research streams focuses on social marketing and corporate social responsibility (e.g., influence of CSR communication on consumers; how to promote more responsible consumer behaviors such as healthy eating; how to curb product obsolescence).

François Maon

François Maon, Ph.D., is Professor of Strategy and Corporate Social Responsibility at IESEG School of Management in France, where he is the head of the Management & Society department. He received his doctorate from the Louvain School of Management, Université catholique de Louvain (UCLouvain), Belgium. His research focuses mainly on organizational processes and activities linked to corporate social responsibility and sustainability learning, implementation, and change. He has published articles in various international journals such as *Organization Studies*, *California Management Review, International Journal of Management Reviews*, and *Journal of Business Ethics*. In addition to co-editing several special issues of academic journals and books, he serves on the editorial review boards of *Business and Society*, *M@n@gement,* and *Journal of Business Ethics*. He is the founder of the IESEG Center for Organizational Responsibility (ICOR).

Valérie Swaen

Valérie Swaen is Full Professor of Marketing and Corporate Social Responsibility (CSR) at the Université catholique de Louvain (Louvain School of Management, Belgium) and at IESEG School of Management (France). Since September 2019, she has served as the president of the Louvain Research Institute in Management and Organizations (LouRIM, UCLouvain). She is also the head of a Louvain CSR network that gathers and supports researchers and practitioners who seek to put responsible leadership and sustainable production and consumption at the heart of their research and strategy. Her research interests include relationship marketing, consumer behavior, CSR, and stakeholders' reactions to CSR communication. She has published in international journals such as *Journal of Management, Journal of Management Studies, Journal of Organizational Behavior, Journal of Business Ethics, Journal of Business Research*, and *Marketing Letters.*

Adam Lindgreen

Professor Lindgreen received his Ph.D. in marketing from Cranfield University. He is Professor of Marketing at Copenhagen Business School (since 2016) where he also heads the Department of Marketing. He is also Extra Ordinary Professor with University of Pretoria's Gordon Institute of Business Science. His publications have appeared in *Journal of Business Ethics, Journal of the Academy of Marketing Science, Journal of Product Innovation Management*, *Journal of World Business*, and *Organization Studies*, amongst other.