Cooperation for innovativeness in SMEs: a taxonomy for cooperation design

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Abstract: Various resource constraints of small and medium-sized enterprises (SMEs) highlight the strategy of cooperation for innovation as it enhances organisations' options and breadth of knowledge sources. Nevertheless, research lacks guidance on why, with whom, and how to cooperate and has so far not provided a comprehensive overview of the characteristics of cooperation to foster SMEs' innovativeness. We build a taxonomy based on deductive and inductive iterations. The taxonomy incorporates insights from literature including information science, innovation management, and organisational science. Further it represents insights from practitioners on cooperation for innovation. Our taxonomy delineates the design options for practitioners and advises that one select organisation-specific parameters. With this taxonomy, we conceptually structure existing research and empower practitioners to analyse their current cooperation projects, reconsider them, and gain knowledge to design new ways of cooperation that best suit their aims.

Keywords: cooperation for innovativeness; innovativeness in SMEs; taxonomy; taxonomy development; cooperation design; small and medium sized enterprises; characteristics of cooperation; practitioner insights; dynamic capabilities; design options.

Reference to this paper should be made as follows: Buck, C., Watkowski, L. and Wyrtki, K. (2022) 'Cooperation for innovativeness in SMEs: a taxonomy for cooperation design', *Int. J. Entrepreneurial Venturing*, Vol. 14, No. 1, pp.53–86.

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1 Introduction

Since completely new environmental conditions generate new demand patterns (e.g., smart things triggering orders), but also create numerous possibilities for shaping markets, market conditions, and customer needs (Cooper and Kleinschmidt, 1995), innovation is increasingly becoming a primary concern for companies (Aagaard, 2012; Cai et al., 2017). Further, digitalisation challenges organisations dramatically with the emergence of numerous technologies (Legner et al., 2017). Rapid technological improvements imply altered customer demands and changing market conditions but also accelerate and improve the ways innovations are developed (Yoo et al., 2010). These digital opportunities, in combination with new business models, create a completely new economic environment. For instance, through digitalisation, physical products are gaining digital capabilities and are becoming increasingly autonomous (Yoo et al., 2010). Digitalisation accelerates the increased interconnection of globalised markets, often putting small and medium-sized enterprises (SMEs) to the limits of their innovative abilities. Since SMEs are exposed to resource constraints such as financial means, engaging qualified personnel, and limited size and scalability (Diez, 2002; Lee et al., 2010; Bouncken et al., 2015), their capabilities to pursue innovation are limited (Nieto and Santamaría, 2010). This increases SMEs' pressure for successful innovation to remain in business (Hitt et al., 1998). Particularly highly innovative ideas bear considerable risk factors (Häckel et al., 2018) and constitute an additional barrier to innovation. Still, SMEs are often incapable of generating innovation (Staniewski et al., 2016; Rogers, 2004), which increases their need to search beyond their boundaries for resources to complement their internal capabilities (Becker and Dietz, 2004).

Cooperation is a way to pursue innovation by complementing internal resources via external partners, e.g., through learning, knowledge-building, and new work methods (Galende, 2006; Wolff and Nuseibah, 2017). Cooperation fosters rapid and cost-effective adaptation to current market situations by sharing the costs and risks of innovating (Casals, 2011). Since SMEs usually have higher resource constraints, engaging in cooperation by sharing and combining resources can foster a company's innovativeness (Scaringella and Radziwon, 2018). Thus, SMEs can bring their qualities into the joint innovation process and specialise as well as learn from their partners. The external knowledge absorbed through cooperation for innovation can be used internally even after a distinct partnership has terminated (De Faria et al., 2010). Thus, from ideation to development and – finally – market introduction, cooperation offers possibilities to overcome barriers that hinder SMEs' pursuits of innovation.

To date, the research has examined only single aspects of SMEs' cooperation to foster innovation. Thus, the body of knowledge has mainly concentrated on relational and governmental aspects, including incentives and behavioural concerns (Okamuro, 2007; Gardet and Fraiha, 2012; Villa and Bruno, 2013). Other studies have predominantly investigated networks as a form of cooperation (Olsen et al., 2012; Pullen et al., 2012; Guercini and Woodside, 2012; Arechavala-Vargas et al., 2012; Nordman and Tolstoy, 2016). Although several aspects of SME cooperation have been in focus, no study has condensed and structured the knowledge. Moreover, practitioners strive to make the best possible use of limited resources regarding innovation development through cooperation and thus seek to classify their efforts by means of a structuring foundation. While searching for potential partners enhancing organisations' options and breadth of knowledge sources (Golonka, 2015), guidance on why, with whom, and how to cooperate is essential in both theory and practice. The research has not provided a comprehensive overview of the characteristics of cooperation to foster SMEs' innovativeness. Consequently, research and practice lack guidance on characteristics of cooperation for innovation. Still, researchers require a thorough foundation serving as a cornerstone for further investigating on cooperation for innovation in SMEs, while enterprises need a structuring element illustrating the design characteristics of cooperation for innovation to evaluate on most suitable options. Hence, we ask: *How does one classify cooperation for innovation in the context of SMEs?*

To answer this question, we follow Nickerson et al. (2013) and develop a taxonomy (Nickerson et al., 2013). In the course of our research process, we deductively derived our taxonomy from the literature and enhanced it with inductively derived insights using 17 real-world examples. Thus, our taxonomy seeks to compile relevant dimensions and characteristics to foster SME innovativeness via cooperation. Our taxonomy comprises 25 characteristics according to 11 dimensions, namely, purpose, value-added, composition, partner source, direction, network range, timeframe, organisation structure, governance, information management, and communication. Through the evaluation with 10 industry experts we demonstrate our taxonomy's usefulness for cooperation for innovation in the context of SMEs. The taxonomy delivers insights for researchers and practitioners to understand the topic better and provide guidance on future decision-making.

The remainder of this paper is structured as follows. In Section 2, we classify the topic into the academic discourse, discussing relevant research contributions. Next, we outline the taxonomy development methodology by applying a rigorous seven-step approach. In Section 4, we present our final taxonomy and, in Section 5, classify real-world objects based on our taxonomy. We then theoretically describe the evaluation of the taxonomy via expert interviews. In Section 6, we summarise our key findings, discuss the study's limitations, and provide an outlook on further research directions.

2 Theoretical background

2.1 The importance of innovation for long-term success

Dynamically evolving environments, rapid improvements in technology, and blurred industry boundaries increase the need for organisations to innovate (Vega and Chiasson, 2019; Yoo et al., 2010). Schumpeter (1912) introduced innovation as a concept of competitive differentiation by realising new combinations of assets and skills. Following this idea, *innovativeness* is the continual application of innovative behaviours at the organisational level over time (Subramanian and Nilakanta, 1996). Realising the importance of innovativeness as the potential to enhance an organisation's competitive advantage both increases strategic power and opportunities and the likelihood of remaining in business (Fichtel, 2013).

We used the dynamic capabilities view (DCV) as our theoretical foundation. While the resource-based view (RBV) treats the organisation as a bundle of heterogeneous resources and competencies (Barney, 1991, 1995), this perspective does not address how currently available resources evolve. The DCV takes a more dynamic view (Ambrosini and Bowman, 2009), accounting for the shortcomings of purely static resource-oriented considerations (Schilke et al., 2018). Helfat and Raubitschek (2018, p. 1393) defined dynamic capabilities (DCs) as "capabilities that enable firms to create, extend, and modify how they make a living, including through alterations in their resources [...] operating capabilities, scale and scope of work, products, customers, ecosystems, and other features of their external environments". Most importantly, DCs allow organisations to continually innovate and adapt to ever-changing market needs (Teece et al., 1997; Zahra and George, 2002). The DCV considers both internally available resources and resources outside the organisation (i.e., other organisations) as resources in a dynamically evolving environment (Helfat and Raubitschek, 2018). Thus, resources heterogeneity, which forms the basis of competitive advancements, is enhanced through the broadened scope of externally available resources (Amit and Schoemaker, 1993; Brunswicker and van de Vrande, 2014; Teece, 2007). The research has provided insights that an organisation's knowledge and, thus, its knowledge management represent DCs that particularly account for innovativeness (Borghini, 2005; Darroch, 2005; López-Nicolás and Meroño-Cerdán, 2011). Accordingly, the capability to recombine and configure widely diffused knowledge to useful solutions-oriented approaches is valuable because markets constantly evolve (Bogers et al., 2019). Further, the set of capabilities to foster innovativeness is supplemented by the capability of disruptive innovation, i.e., applying internal and external resources to foster opportunity-led radical ideas (Assink, 2006).

A major theory in innovation is absorptive capacity. Cohen and Levinthal (1990) were integral to define absorptive capacity as "the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends (...)" (Cohen and Levinthal, 1990, p.128). According to Fabrizio (2009), this is directly linked to the use of knowledge by firms that pursue innovation. Building on the individual level, Cohen and Levinthal (1990) found that existing knowledge facilitates the ability to acquire new knowledge. To develop an absorptive capacity, one must deal intensively with the subject area in question (Cohen and Levinthal, 1990). Further, they consider absorptive capacity to be cumulative: companies that do not support the absorptive capacity they have acquired lose it (Cohen and Levinthal, 1990). This also explains why many companies conduct basic research. The resulting absorptive capacity, in combination with the background knowledge gained, creates a deep understanding that enables one to make sense of new developments and to respond faster to competitors' new technologies (Cohen and Levinthal, 1990). The absorptive capacity literature has revealed several advantages in relation to a number of corporate activities, including shorter innovation cycles (Fabrizio, 2009). An important addition is the work by Zahra and George (2002), who, using DCs theory, divided absorptive capacity into *potential capacity* (as knowledge acquisition) and *realised capacity*, which they divide into knowledge transformation and knowledge use. They did this because potential capacity often receives little attention in the research, although it would give companies the necessary strategic flexibility and would enable a long-term competitive advantage, even in a dynamic industry (Zahra and George, 2002).

Using innovation as a tool to sustain long-term competitive advantage is of great interest to organisations (Grossman and Helpman, 1994; Sedera et al., 2016). SMEs are drivers of economic and societal success since they represent almost 99% of the organisations in European countries and, thus, play a key role in employment (Eurostat, 2018). Further, in many or even most SMEs, the owners are active in top management; also, SMEs often have family structures (Gubitta and Gianecchini, 2002). A need for cooperation for innovation drives organisations of every size, but challenges especially SMEs, which are burdened by resource constraints such as financial means, engaging qualified personnel, and limited size (Bouncken et al., 2014; Diez, 2002; Lee et al., 2010), which limit their capabilities to pursue innovation (Nieto and Santamaria, 2010). Cooperation positively stimulates the innovation and extends an organisation's scope of action (Golonka, 2015; Morgan and Cooke, 1998). From a theoretical and a practical perspective, cooperation is a sufficient option for SMEs to overcome resource barriers that hinder them from innovating (Iturrioz et al., 2015; Tomlinson and Fai, 2013).

2.2 Cooperation as an enabler of innovation in SMEs

Cooperation can be used to apply DCs in terms of reconfiguring competencies and adjusting to changing market demands as new combinatory options are revealed. We follow management theory research streams that define cooperation as ties between organisations with a shared goal and a shared understanding of contributions (i.e., resources and competencies) (Gulati et al., 2012; Majchrzak et al., 2015; Parkhe, 1993; Salvato et al., 2017).

Cooperation can be formed with various distinctions and specifications. This is plausible, since cooperation can have different purposes (Beron et al., 2003; Mahnke et al., 2008; Parkhe, 1993). The various designs of cooperation bear different advantages and disadvantages. Following these considerations, the diversity of cooperation has been studied for many years, leading to a vast literature (Hagedoorn et al., 2000; Raposo et al., 2014; Rosenfeld, 1996). Focusing on cooperative value creation, i.e., the total added value by a collaborative effort among participants (Wagner et al., 2010), Hillebrand and Biemans (2003) stated that the literature on cooperation addresses either proprietary or open cooperation.

While proprietary approaches with known organisations from the narrow business community favour greater stability and control (Hillebrand and Biemans, 2003), more open approaches foster greater growth (Appleyard and Chesbrough, 2017; Cohen and Levinthal, 1990; Hossain and Kauranen, 2016; Usman et al., 2018). However, innovating proprietarily brings challenges of adequately exploiting ideas (van de Vrande et al., 2009; West and Gallagher, 2006) since internal ideas may be limited to an organisation's existing knowledge base, technologies, and organisation-specific knowledge development capabilities (Ferreira et al., 2020; Mudambi and Tallman, 2010). Focusing on cooperative value creation, open innovation can include a vast number of partners, reducing costs and enhancing the quality of the outcomes in contributing their diversity to a project (Baldwin and Clark, 2000; Xie et al., 2018). Considering different external cooperation types, organisations can seek to either enhance existing knowledge (Faria et al., 2010) or to pave the way for new knowledge streams (Bercovitz and Feldman, 2007). As the latest research shows, deciding for either approach is not a static determinant; this should evolve dynamically (Appleyard and Chesbrough, 2017).

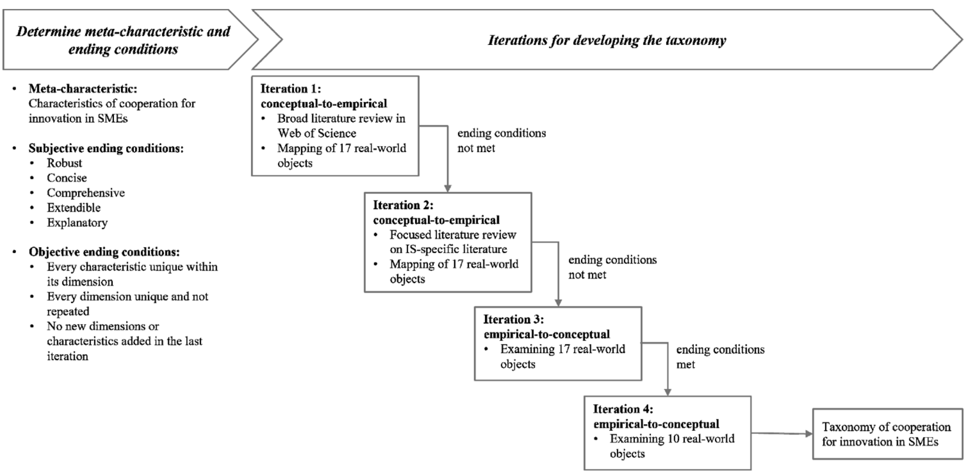
More granular research considers single aspects of cooperation. Depending on the cooperation's purpose and the decision for proprietary or open innovation, the opportunities to cooperate can vary greatly regarding characteristics such as the number of partners involved (Thorgren et al., 2009), the partner types (Baba et al., 2009), and the governmental setting (Gancarczyk and Gancarczyk, 2016). Further, as sources of cooperative work focus on different particularities, they use various designations ranging from research partnerships (Hagedoorn et al., 2000), to knowledge networks (Owen-Smith and Powell, 2004), to R&D consortia (Sakakibara, 2002), displaying the research's heterogeneity. Through digitalisation's influence on daily processes and the ways organisations work, the possibilities to cooperate increase, enabling new forms of cooperation (Rachinger et al., 2019). Thus, digitalisation not only influences how organisations cooperate – for instance, e-collaboration within and between organisations (Riemer et al., 2009) – but also why organisations cooperate – for instance, implementing Industry 4.0 solutions based on joint resources (Müller et al., 2017). Besides theoretical contributions (e.g., Teece et al., 1997), widely studied practical contexts emphasise the importance of cooperation for innovation in practice (Bayona et al., 2001; e.g., Okamuro, 2007).

SMEs can use cooperation to complement their internal resources in their innovation strategy and can focus more on generating innovation. While the research into cooperation for innovation has presented fruitful theoretical groundwork, it has not yet provided a structured overview of the various facets of cooperation available to organisations and certainly to SMEs. Contributions have focused on single aspects of cooperation for innovation work and have remained narrow; this lack is further stressed by the ever-growing options opened up by digitalisation (Rachinger et al., 2019). Further, no adequate decision support for SMEs exists to explore the various options for cooperation for innovation projects. We address these constraints, contributing to the descriptive knowledge on cooperation among SMEs with a focus on innovativeness using both a structured approach and delineating the design options for SME practitioners, advising on the selection of organisation-specific parameters.

3 Research method

Seeking to classify cooperation types used by SMEs to foster innovativeness, a taxonomy offers a structured view to organise knowledge on this topic while enabling researchers and practitioners to understand the investigated domain (Nickerson et al., 2013). We applied the taxonomy development procedure of Nickerson et al. (2013) that provides a systematic and rigorous development approach and has proven to be a useful tool to build domain-specific taxonomies (e.g., Lösser et al., 2019). Figure 1 depicts the process we followed, as proposed by Nickerson et al. (2013).

Figure 1 Research method



The first step is to define a meta-characteristic which serves as foundation for the subsequent definition of the taxonomy's dimensions and characteristics. In line with the research question, we defined the following meta-characteristic: *characteristics of cooperation for innovation in SMEs*. Next, as step 2, we defined objective and subjective ending conditions. The defined ending conditions are checked after each iteration in the taxonomy development process. Their fulfillment determines when to terminate the iterative development of the taxonomy. We defined the objective ending conditions in line with Nickerson et al. (2013):

1 each characteristic is unique within its dimension (no duplication)

2 each dimension is unique and is not repeated in the taxonomy (no duplication)

3 an iteration does not imply further modification of the taxonomy.

We assumed subjective ending conditions to be met, if the taxonomy is considered concise, robust, comprehensive, extendible, and explanatory (Nickerson et al., 2013).

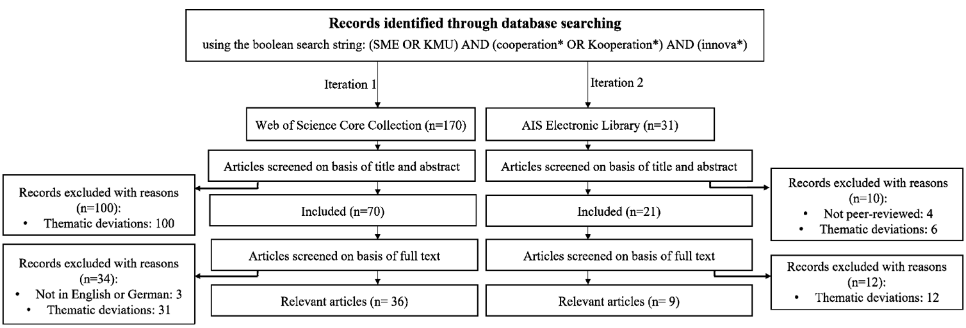
The taxonomy development iterations (steps 3–7) start either with a conceptual-to-empirical or an empirical-to-conceptual approach. Nickerson et al. (2013) allow these approaches to be mixed between different iterations. As for conceptual-to-empirical iterations, the taxonomy's characteristics and dimensions are derived from the literature related to the meta-characteristic. They advise starting with a conceptual-to-empirical approach when researchers have a good understanding of the underlying research field but little available data. Therefore, researchers can derive dimensions and objects based on justificatory knowledge, followed by mapping real-world objects to the developed taxonomy. As for empirical-to-conceptual iterations, characteristics and dimensions are drawn from a sample of real-world objects. Starting with the empirical-to-conceptual approach, on the other hand, is advised when researchers have a large set of objects at hand, but little knowledge about the research discipline. Dimensions and characteristics are then derived by studying the objects in detail (Nickerson et al., 2013). The taxonomy development process iterates until the ending conditions are met. To create the taxonomy, we conducted four iterations (Figure 1) that are detailed in the following.

Iteration 1: Conceptual to empirical

For the first iteration, we chose to start with the deductive conceptual-to-empirical approach. This is reasonable, since there is a large body of literature on cooperation for innovation in SMEs, which served as the starting point for the taxonomy development process. Based on justificatory knowledge, we were able to derive dimensions and characteristics, followed by mapping real-world objects to the developed taxonomy (Nickerson et al., 2013).

To build a conceptual body of knowledge for further iterations, we conducted a structured literature review (SLR) (Figure 2) (vom Brocke et al., 2015; Webster and Watson, 2002). This is appropriate since, to our best knowledge, there is as yet no structured knowledge on cooperation for innovation among SMEs that could have served as the basis of a taxonomy. In line with best practice (Short, 2009), we used Web of Science Core Collection (WoS), a curated set of more than 20,000 peer-reviewed scholarly journals published worldwide, also covering literature on cooperation in innovation, to conduct the literature search. To identify relevant literature, we deliberately chose a broad search string and searched for papers and proceedings papers related to cooperation for innovation of SMEs. We used the bilingual (i.e., English and German) Boolean search string (SME OR KMU) AND (cooperation* OR Kooperation*) AND (innova*) searching in titles with no restriction in timeframe (all years 1970–2019), resulting in 170 papers. We used an iterative approach to identify relevant papers. First, to decide about the literature's relevance, we screened the title and abstract of each paper and excluded 100 papers as these had no relation to the cooperation for innovation of SMEs. To make this process more comprehensible, we used a four-point Likert scale, assigning a score to every paper: 4 = the paper mentioned the search terms in a context that had no connection to the research question at all; 3 = the appearance of the search terms showed a slight reference to the context of cooperation for innovation in SMEs but no further contribution to our research question; 2 = the use of the search terms had a connection to our research question; 1 = the search terms appeared in a context strongly related to the scope, and a major contribution to our research question is expected. This scale allowed freedom to the researcher and assignment based on his contextual knowledge; for instance, the publication by Iturrioz et al. (2015) was ranked as 1 since it deeply investigated SME cooperation and used an illustrating real-world example, enabling us to gain theoretical as well practical insights. In contrast, we scored the publication by Černá (2014) as 4, since the abstract revealed that the research purpose was the suitability of new IS implementation and the searched keywords only appeared randomly but did not relate to our research. Ranking the papers based on the Likert scale was useful to condense the number of publications we read in-depth, allowing us to concentrate on those that seemed closest to our research question. Due to our inclusion and exclusion criteria, 100 papers were excluded by thematic deviations in regarding titles and abstracts. Second, we read in-depth 70 (41%) of the papers that we scored as 1 and excluded 34 papers based on language (neither German nor English) and thematic deviations. The remaining 36 papers (for further details, see Appendix A: References of a Structured Literature Review) of the in-depth screening process provided the basis for the first iteration of the taxonomy development approach.

Figure 2 Literature review



Steps 4–6 of the taxonomy development approach spanned from analysing the literature to creating the taxonomy. We derived the first version of the taxonomy by extracting dimensions and characteristics of the 36 relevant papers. In this process, the co-author who compiled the initial taxonomy discussed every dimension and characteristic according to the meta-characteristic with another co-author so as to guarantee a shared understanding. We examined the dimensions and characteristics to check for duplicative expressions and redundancy.

We challenged the dimensions and characteristics of the developed taxonomy by mapping real-world objects to it (Nickerson et al., 2013), validating the taxonomy regarding how well it represents the characteristics of real-world objects (Oberländer et al., 2018). We sampled the set of real-world objects as follows. We purposively sampled diverse objects of SMEs' cooperation for innovation initiatives (i.e., objects across industries and countries) from papers included in our literature review. Since the literature provided by our SLR covered the research topic appropriately, it presented us with a valid sample. To extend our sample, especially including more recent and further relevant real-world objects, we also did a review via Google search using the term *cooperation SME innovativeness*, leading to a resulting set of 17 objects (see Appendix B: An Overview over the Cases). We mapped this sample against the first version of the taxonomy for further development.

Comparing the subjective and objective ending conditions with the derived taxonomy revealed that the ending conditions were not met (i.e., conciseness, comprehensiveness; no new dimensions or characteristics were added in the last iteration) and at least one further iteration was needed to terminate the taxonomy development.

Iteration 2: Conceptual to empirical

For iteration 2, we again followed the conceptual-to-empirical approach, with the focus on IS-specific literature to account for the changes in cooperation through digitalisation. We included contributions from the Association for Information Systems Electronic Library (AISeL) (i.e., known IS conferences and journals) so as to ensure high-quality and timeless research into the topic. Using the aforementioned search string led to the retrieval of 31 papers (Figure 2). Again, we reviewed these based on the title and the abstract and, if there was the potential of major contributions, read them in-depth. We excluded 10 papers that were not peer-reviewed or not available in full-text. Thus, 21 (68%) papers remained to be read in-depth. Again, 12 papers were excluded due to thematic deviations (Figure 2). We included nine remaining publications in further developing the taxonomy (see Appendix C: References of a Structured Literature Review).

We added two dimensions with four characteristics to the previously derived taxonomy. The set of 17 objects was consecutively mapped on the new taxonomy. We then discussed the results and revised the taxonomy. The derived taxonomy from this iteration did not fulfil all the ending conditions, i.e., no new dimensions or characteristics were added in the last iteration.

Iteration 3: Empirical to conceptual

Thus, the third iteration took an empirical-to-conceptual approach. The choice was driven by the consideration to examine different real-world objects to check on differentiating characteristics and dimensions in application (Nickerson et al., 2013). Further, the taxonomy disclosed a need to check practicability through the use of real-world objects. We classified our set of 17 real-world objects to identify gaps that the previously examined literature did not account for and to validate the taxonomy's structure. Throughout this mapping process, we compared new findings from real-world-objects with the proposed taxonomy and adjusted the taxonomy iteratively. This approach enabled us to enhance the literature-backed taxonomy with evidence from heterogeneous real-world objects and to refine our initial taxonomy. For the list of 17 real-world objects, which we analysed for inductive validation and refinement, see Appendix 3. Owing to changes made to the taxonomy, the ending conditions were not met. We included a fourth iteration.

Iteration 4: Empirical to conceptual

Iteration 4 took an empirical-to-conceptual approach. Besides evaluating the taxonomy with real-world objects compiled from the literature, we incorporated the knowledge of experts in SME cooperation. When selecting the experts, we followed an expert sampling approach, inviting industry experts from our networks (Bhattacherjee, 2012). However, we also sought to achieve sufficient variation within our final sample regarding the size and industry of the organisations so as to offset potential biases. In sum, we ensured that every interviewee held a position that provided them with needed insights into and expertise in relevant cooperation for innovation projects. Further, we specified that they had to work in organisations that are SMEs, according to our definition's criteria. When conducting semi-structured interviews with the industry experts, we discussed the dimensions and characteristics, including a real-world object mapping by the industry expert, to evaluate comprehensiveness, consistency, and problem adequacy. We also used the interviews to review our evaluation criteria. The interviews lasted between 15 and 60 minutes and were attended by at least one co-author. Beyond enhancing and validating our taxonomy, they provided us with rich insights into the previously defined evaluation criteria, which we will discuss in some detail in Section 5.2.

The taxonomy development process terminated after this iteration, since both the subjective and objective ending conditions were fulfilled. Owing to the SLR, the comprehensive analysis of real-world objects, and the evaluation with expert interviews, we are confident that the revised taxonomy (as presented in Section 4) appropriately reflects the manifold options available to SMEs for designing cooperation in innovation projects.

4 A taxonomy on cooperation for innovation in the context of SMEs

We will now present our final taxonomy, which consists of 11 dimensions encompassing 25 characteristics that we defined according to the specified meta-characteristic to describe cooperation to foster innovativeness in SMEs (Table 1). We derived the dimensions purpose (Mahnke et al., 2008; Olsen et al., 2012), resource (Bengtsson and Johansson, 2014; Iturrioz et al., 2015), composition (Gardet and Fraiha, 2012; Gnyawali and Madhavan, 2001; Wolff and Nuseibah, 2017), partner source (Brink, 2017; McAdam et al., 2014), direction (Hadjimanolis, 1999), network range (Gnyawali and Park, 2009; Iturrioz et al., 2015), timeframe (Das, 2006), organisation structure (Golonka, 2015; Villa and Bruno, 2013), and governance (Dekker, 2004; Okamuro, 2007; Thorgren et al., 2009), including their characteristics, in iteration 1 of the taxonomy development based on an SLR. In a second iteration, with a focus on the IS literature, the dimensions information management (Damsgaard and Lyytinen, 1998; Li et al., 2016; Scholz-Reiter and Krause, 2001) and communication (Howard et al., 2003; Wildemann et al., 2005) were added to the taxonomy. Every dimension is described in detail in the form of a question, which is supposed to be answered through the respective dimension and its characteristics. We will now explain the practical relevance of every dimension and characteristic and will outline its meaning.

4.1 Purpose

In line with the meta-characteristic, the overall objective for cooperation is innovativeness. The dimension purpose defines the objective of the cooperation, which is structured with the taxonomy at hand. The subsequent cooperation purpose can either be defined or undefined. Defining explicit or implicit goals largely depends on the cooperating partners' motivations and expectations (Mahnke et al., 2008) and refers to the aspect of why one should develop and join a cooperation. A previously defined purpose exists when, for instance, a cooperation partner has specified requirements prior to a cooperation, while in undefined cooperation, purpose is developed during cooperative work. The purpose also indicates which cooperation design fits best and thus influences the cooperation specifics, i.e., following the dimensions and characteristics of our taxonomy (Olsen et al., 2012).

Table 1 A taxonomy on cooperation for innovation among SMEs

Dimension	*Characteristics*	*Description*	*ME/NE*
Purpose	Defined | Undefined	Is a goal specified?	ME
Value-added	Supplementary | Complementary	Are the assessed resources supportive or additional?	NE
Composition	Material | Immaterial	Which resource type is sought?	NE
Partner source	Internal | External	What is the origin of cooperation?	NE
Direction	Horizontal | Vertical | Lateral	Links with partner/s?	NE
Network range	Bilateral | Multilateral	How many partners are involved?	ME
Timeframe	Short-term | Mid-term | Long-term	How long is the cooperation supposed to last?	ME
Organisation structure	Hierarchy | Heterarchy	How is cooperation organised?	ME
Governance	Formal | Informal | Agent	What is the applied regulatory framework?	ME
Information management	Manual | Automatic	How is information shared?	NE
Communication	Real | Virtual	Which interaction type is used?	NE

[1]ME = Mutually exclusive dimension (one characteristic observable at a time);
NE = Non-exclusive dimension (potentially multiple characteristics observable at a time).

4.2 Value-added

The dimension value-added is mainly driven by the limitedness of resources in an organisation (Li et al., 2016). Every cooperation partner comprises a unique bundle of heterogeneous resources and competences (Ambrosini and Bowman, 2009). Following the RBV, such bundles are a source of competitive advantage (Hitt et al., 2000), to which the DCV adds a more dynamic view (Ambrosini and Bowman, 2009). The decision for or against a possible cooperation partner is determined by the question what the organisation seeks and needs (Iturrioz et al., 2015; Sawers et al., 2008). Resources that support existing resources and broaden their potential (i.e., are supplementary) are strived for when organisations are eager to, for instance, pool quantities to purchase in more beneficial conditions. Resources that add up to the existing portfolio (i.e., are complementary) are sought when no or only a small amount of the resource is available to the organisation, but a need exists and operation is restricted. For instance, know-how for new ideas that can predominantly be found in research institutes (Bengtsson and Johansson, 2014; Casals, 2010; Iturrioz et al., 2015).

4.3 Composition

The dimension composition refers to the various resources an SME strives for in cooperation. Following the differentiation in both the RBV and the DCV, these resources can either be material (e.g., production site, research equipment) or immaterial (e.g., knowledge, competencies, status) (Ambrosini and Bowman, 2009; Barney, 1991, 1995). While status is especially important for small new organisations that benefit from cooperators known to the business (Gnyawali and Madhavan, 2001), research insights can help established SMEs that strive for innovation (Wolff and Nuseibah, 2017). Depending on the course of action, the resources organisations opt for can change during a cooperation (Gardet and Fraiha, 2012). This is the case if, for instance, technical knowledge is needed at the beginning of a project yet later phases depend on more marketing and commercialisation skills.

4.4 Partner source

The dimension partner source refers to whether the cooperation includes partners from inside the organisation, (i.e., internal) or from outside the organisation (i.e., external) (Brink, 2017; McAdam et al., 2014; Swaminathan and Moorman, 2009). Internal partners could stem from other departments or other legal entities in the same organisation (Griffin and Hauser, 1996; Hillebrand and Biemans, 2003). External partners may include startups, competitors (Bouncken and Kraus, 2013), suppliers (Tomlinson and Fai, 2013), government institutions (Navickas and Malakauskaite, 2009), research centers (Zeng et al., 2010), and educational institutions (Pereira and Franco, 2021); these vary in (cooperating partner) type and size. The first source to recruit partners typically stems from the direct business environment of an organisation but is not restricted to it (Brandenburger and Nalebuff, 2011). Instead, the open innovation approach emphasises the value-creating opportunities that lie beyond known knowledge streams (Chesbrough et al., 2006).

4.5 Direction

Organisations can acquire cooperation partners from various sources. Depending on the pursued goal and expectations, organisations can choose their partners strategically. Inter-organisational links (i.e., direction) consist of vertical, horizontal, or lateral bonds (Hadjimanolis, 1999). Vertical links exist when a partner stems from upstream or downstream the value chain, for instance, a supplier or a customer (Okamuro, 2007). In this direction, the involved parties can focus on their core competencies (Villa and Bruno, 2013). There is horizontal cooperation when one works with partners on the same level of the value chain, such as competitors (Tomlinson and Fai, 2013). This can be advantageous when looking to combine resources, for instance, to offer services acting as one organisation (Li et al., 2016). A lateral direction implies that the partner has no connection to the own value chain and instead stems, for instance, from a different industry (i.e., cross-sectoral). This form of cooperation can be a source of ideas that are new to an industry.

4.6 Network range

The network range of cooperation can be bilateral (i.e., two partners) or multilateral (i.e., various partners are involved). Partnerships only exist between two parties and form stronger bonds than mere informal interaction (Navickas and Malakauskaite, 2009). This tightness is often used to cooperate strategically (Thorgren et al., 2009). Multilateral cooperation can support the transdisciplinary knowledge exchange between research institutes, government, and industry partners (Wolff and Nuseibah, 2017) and can occur in forms such as networks, clusters, or more specialised technology platforms. It can make the knowledge gained via research and governmental support available and applicable to the economy. A cluster that is multilateral in network range, for instance, embodies a cooperation type that can bind integral regional players from society and industry, affecting the performance in a certain local area. The network range is generally strongly determined by the search for roles and single actors' strength (Iturrioz et al., 2015). Multilateral ties loosen the dependency on single cooperation partners and allow for more heterogeneously distributed partners (Gnyawali and Park, 2009).

4.7 Timeframe

The dimension timeframe distinguishes between the different cooperation agreement lengths. Short-term cooperation can exist in the form of project-focused work with few strategic implications (Bengtsson and Johansson, 2014). Deciding for short-term cooperation can be driven by pressure for rapid results (Das, 2006). Mid-term refers to a duration between short-term and long-term cooperation agreements, while long-lasting cooperation tends to lower the risk of opportunistic behaviours and to increase the social cohesion between the involved parties (Schubert and Leimstoll, 2007). Long-term alliances can address strategic challenges with joint interests. Generally, the duration of a cooperation can be an indicator of the depth and integrity of the work (Swaminathan and Moorman, 2009). Since the characteristics in this dimension can differ greatly depending on the industry and the cooperation type, they are not further specified to concrete timeframes.

4.8 Organisation structure

The dimension organisation structure refers to the internal decision-making structure. Here, it is represented by either a heterarchical or a hierarchical approach (Golonka, 2015; Thorgren et al., 2009). Heterarchy is a consensus-based method of working together, while hierarchy consists of levels of dominant roles and can be steered by a leading firm (Villa and Bruno, 2013). Thus, the extent of dependence varies and can concentrate on one actor in an unequal partnership or a few partners in larger networks (Gardet and Fraiha, 2012). The cooperation architecture also influences several further aspects, such as the governance model (Li et al., 2016).

4.9 Governance

The dimension governance contributes to how different governance modes impact the roles, relationships, and competitive positions of partners in a cooperation (Gancarczyk and Gancarczyk, 2016). The governance model is particularly important, since it builds the framework by either impeding or supporting innovative activities (including knowledge-sharing). Governance can take diverse forms and, according to our taxonomy, has three characteristics: formal, informal, and agent. Formal cooperation is often achieved through contracts (Okamuro, 2007), but also strongly depends on a partner being reliable. Depending on the situation, an unbureaucratic or more formal approach is needed; for instance, joining the cooperation typically includes some contractual agreement, while the first meeting or later sessions are shaped by informal communication. Informal cooperation is mainly based on trust (Das and Teng, 1998; Larson, 1992; Nuissl, 2005). If the cooperators can rely on trust, minor modes of formal governance are observed. Another governance type is an agent, fulfilling multiple roles within the regulatory framework of the cooperation. An agent assists the cooperating partners, addresses their individual needs and problems, aligns their activities toward the overall goal, and is thus engaged in network creation (Estensen et al., 2016; Leckel et al., 2020).

4.10 Information management

Information management refers to the inter-organisational exchange of information and the way the information is exchanged between the participating organisations (Scholz-Reiter and Krause, 2001). This can either be done manually or automatically with a paperless exchange system (Damsgaard and Lyytinen, 1998). Manual information transfer can lead to time lags and creates a barrier to direct information flows, while an automated system can function as an intertwined structure between the organisations instead of coexisting systems (Li et al., 2016). Specifically, organisations use automated exchange systems to improve their cooperative capabilities (Segars and Chatterjee, 2003). Examples include the integration of multiple organisations and their information systems, for instance, Shanghai Health Information Exchange, which connects more than 100 medical record systems operated by 69 hospitals (Du et al., 2019).

4.11 Communication

The dimension communication refers to the network structure that every cooperation consisting of people at least indirectly includes (Wildemann et al., 2005). This network structure can be real (i.e., direct social interaction without physical distance) or virtual. In this context, virtual refers to people of organisations interacting with one another using digital communication tools such as internal social networks or telecommunication systems (Li et al., 2016). This can go as far as taking the form of acting as a single organisation (Howard et al., 2003). According to Carayannis et al. (2000), communication is crucial for success when several partners are involved in a project. Specifically, the applied communication type influences the project work and can either be a driver or a barrier to project success.

5 Evaluation

Once we had completed the first two inductive iterations for building the taxonomy based on the literature, we incorporated two deductive iterations for evaluating the taxonomy with real-world objects and industry experts. The evaluation validated the taxonomy's usefulness and robustness (Nickerson et al., 2013). Our evaluation had two parts. First, we demonstrated our taxonomy's usefulness and practical relevance by applying it to 17 real-world objects (iteration 3, Section 5.1); second, we evaluated the taxonomy regarding evaluation criteria with 10 experts from industry and incorporated their knowledge (iteration 4, Section 5.2) (Myers and Newman, 2007).

5.1 Application of the taxonomy

We present three exemplary cooperation for innovation cases derived from a structured search to demonstrate our taxonomy's applicability. Applying a taxonomy to real-world objects is a form of illustrative scenario and is often used for evaluation purposes of taxonomies (Szopinski et al., 2019). This procedure allowed us to check the taxonomy's usability while conducting the iterative process. Further, using the taxonomy for application purposes reveals its usefulness and shows whether it reflects the real-world objects' characteristics.

5.1.1 Real-world object 1: old building, new isolation

Fixit is an SME that provides innovative isolation solutions to the construction industry (Fixit, 2020). Empa is a research institution for materials science and technology that supports and works with industry partners to create and develop innovative solutions (direction: vertical) (Empa, 2020). Both were cooperating in a project focused on developing a new construction material that has an isolating effect on house walls (Table 2) (purpose: defined; partner source: external; network range: bilateral). The project partner contributed with either a practical or theoretical approach and worked closely without a leading organisational role but certainly with a degree of formalised commitment (organisation structure: heterarchy; governance: formal). Thus, Fixit benefited from Empa's theoretical contributions and was able to test a newly developed building material over four years, gaining insights for practice (timeframe: long-term; value-added: complementary; composition: immaterial) (Empa, 2012, 2014). Since teams from both organisations were working on a highly chemical and technical innovation that required iterative and ongoing exchange, it is expected that information was forwarded in person and using computer data exchange for technical results (information management: manual and automatic). Owing to geographical proximity, communication is expected to be in person unless team-specific subprojects were performed (communication: real).

Table 2 Real-world object 1: old building, new isolation

Dimension	*Characteristic*
Purpose	Defined | Undefined
Value-added	Supplementary | Complementary
Composition	Material | Immaterial
Partner source	Internal | External
Direction	Horizontal | Vertical | Lateral
Network range	Bilateral | Multilateral
Timeframe	Short-term | Mid-term | Long-term
Organisation structure	Hierarchy | Heterarchy
Governance	Formal | Informal | Agent
Information management	Manual | Automatic
Communication	Real | Virtual

5.1.2 Real-world object 2: SmarDe's@Work – Smart devices in the production area

SmarDe's@Work – Smart Devices in the Production Area is a consortial research project funded by the Bavarian Research Foundation to develop middleware combined with a client application for various smart devices (Table 3) (purpose: defined) (König et al., 2019). The project is supported and conducted by several partners from research and various industries (partner source: external; direction: lateral; network range: multilateral) (König et al., 2019). The two research institutes, Fraunhofer FIT and IPA, organisationally led the project but fostered cooperation at the same level (organisation structure: heterarchy). The single project partners contributed research knowledge or implementation options to explore the technology's impacts and revenue possibilities (value-added: complementary; composition: material and immaterial). The project had a duration of two years, with predefined milestones (timeframe: mid-term). The organisations expressed their willingness to participate in the project through a formal commitment in the form of capital resources and a contract (governance: formal). During the SmarDe's@Work project, information was shared automatically using platform sharing tools for inter-organisational information transfer between the project partner (information management: automatic), and the consortium communicated in various ways, via digital technologies such as virtual weekly meetings and via in-person meetings (communication: real and virtual).

Table 3 Real-world object 2: SmarDe's@Work – smart devices in the production area

Dimension	*Characteristic*
Purpose	Defined | Undefined
Value-added	Supplementary | Complementary
Composition	Material | Immaterial
Partner source	Internal | External
Direction	Horizontal | Vertical | Lateral
Network range	Bilateral | Multilateral
Timeframe	Short-term | Mid-term | Long-term
Organisation structure	Hierarchy | Heterarchy
Governance	Formal | Informal | Agent
Information management	Manual | Automatic
Communication	Real | Virtual

5.1.3 Real-world object 3: agricultural forecasting

The Agricultural Forecasting project is a cooperation between SMEs and other partners from diverse industries, research centers, and a university, which committed various competencies to the project (resource: complementary; partner source: external; network range: multilateral) (Table 4). The aim was to develop a tool that supports farmers of any size to manage their business and to identify the situations on the fields using the newest satellite technology (value-added: defined) (Interview Expert 9). The two involved SMEs contributed technical expertise to transmit and intelligently process data generated by the satellite system to corresponding agricultural machines and farmers (composition: immaterial). Needed algorithms and artificial intelligence were serviced by a university, while experts from the German Aerospace Agency provided the newest satellite technology. To practically test the tool, a large agricultural holding provided fields and machines (composition: material) (Interview Expert 9). The project involved end-customers as well as research institutes and lasted more than three years. The goal was to test the tool during all agricultural seasons and retest it during the following year (direction: horizontal and vertical; timeframe: mid-term). The cooperation was organised by a leading organisation that was also the project's initiator; it merged the single outcomes of the project from the partners and informed project stakeholder (organisation structure: hierarchy; governance: agent). Personal contact was important, and information was shared manually between the project partners (information management: manual; communication: real).

Table 4 Real-world object 3: agricultural forecasting

Dimension	*Characteristic*
Purpose	Defined | Undefined
Value-added	Supplementary | Complementary
Composition	Material | Immaterial
Partner source	Internal | External
Direction	Horizontal | Vertical | Lateral
Network range	Bilateral | Multilateral
Timeframe	Short-term | Mid-term | Long-term
Organisation structure	Hierarchy | Heterarchy
Governance	Formal | Informal | Agent
Information management	Manual | Automatic
Communication	Real | Virtual

5.2 Evaluation of the taxonomy

To provide proof of value on the taxonomy's use, we conducted 10 interviews with industry experts (IEs) to evaluate our taxonomy, as described in Section 3 (Myers and Newman, 2007) (Table 5). Expert interviews help to identify possible deviations between the taxonomy's specifications and its objectives (Sonnenberg and vom Brocke, 2012). Thereby, expert interviews help to determine whether the developed taxonomy progresses to a solution of offering guidance in designing cooperation for innovation better than the current state of knowledge and thus makes a valuable contribution within this topic (Leukel et al., 2014).

Considering the criteria proposed by Sonnenberg and vom Brocke (2012), Lund (2001), and March and Smith (1995) our taxonomy evaluation should provide insights into the taxonomy's comprehensibility (i.e., the quality of being easy to understand), understandability (i.e., the quality of being easily comprehended), ease-of-use (i.e., the quality of being easily utilised), fidelity with real-world phenomena (i.e., the level of realism), and applicability (i.e., the quality of the taxonomy being relevant) as represented in Table 6.

Table 5 Descriptive details of the 10 semi-structured interviews with experts

IE	*Interviewee's role*	*Industry*	*Work experience*	*Experience in innovation projects*	*Employees* (2020)
1	Chief Financial Officer	IT, media, and telecommunication	30 years	30 years	42
2	Chief Executive Officer	Building materials	12 years	9 years	100
3	Chief Executive Officer	Software	12 years	4 years	32
4	Working Student	Lighting	2 to 3 years	6 months	30
5	Project Manager	Applied sciences	4 year	2 years	100
6	Chief Executive Officer	Polymer processing	13 years	2 years	70
7	Head of Technical Customer Service	Metal processing	16 years	9 years	150
8	Chief Executive Officer	IT	35 years	20 years	10
9	Data Scientist and Product Owner	IT helpdesk support	11 years	9 years	500 to 550
10	Operations Manager	Metal processing	30 years	15 years	185

We structured the interviews as follows: first, every expert classified an own project case to understand the taxonomy's dimensions and characteristics and illustrate its applicability. We ensured feedback and allowed for additional suggestions regarding the taxonomy. Second, we incorporated semi-structured statements (e.g., I could imagine applying the taxonomy in the future) following the evaluation criteria proposed by Sonnenberg and vom Brocke (2012) to structure the taxonomy's evaluation (Table 6) to get further evidence on the proposed evaluation criteria, the interviewees evaluated the taxonomy holistically, the corresponding dimensions, and specifically the characteristics. Therefore, the interviewees gave additional feedback concerning suggestions toward either how the overall taxonomy, a dimension, or characteristic should be adapted to enhance its use.

In sum, the interviews with 10 industry experts produced the following results: many experts highlighted that cooperation for innovation projects are a common way to overcome resource constraints, undermining our research's importance. They confirmed that the iterative development procedure of Nickerson et al. (2013) and our taxonomy is both suitable for deriving and depicting distinct dimensions and characteristics on cooperation for innovation projects and thus supports the formation of cooperation. The application of the taxonomy enables more efficient and effective identification of over-represented, under-represented, or sufficiently represented characteristics in current cooperation projects and therefore of not-yet-used cooperation opportunities. Having discussed the evaluation criteria, we are confident about our research question's relevance, our research process's rigidity, and our taxonomy's applicability in research and practice.

Table 6 Details about the interviewees

Evaluation criterion	*Evaluation method*	*Interview results*	*Example quotations*
Comprehensibility	Expert interviews	Overall, the taxonomy was comprehensible to the experts and represented the characteristics in a structured and intuitive way. Considerations for improvement include additional information regarding the single dimensions and the characteristics	"*An additional description pointing out the difference between the characteristics would be desirable.*" (IE9)
Understandability	Expert interviews	The taxonomy leaves no open questions. A further enhancement would be explanations as proposed in this work, specifying the dimensions and characteristics	"*No open questions when explained.*" (IE1)
Ease-of-use	Expert interviews	The experts confirmed that the taxonomy is useful and can generally be applied in early and later phases of cooperation projects to either specify or map a cooperation project. Further, the *ease-of-use* is approved of, since the taxonomy delivers a framework to structure cooperation. By classifying and comparing several cooperation projects, practitioners can identify characteristics that are over-, under-, or sufficiently represented in the overall cooperation portfolio	"*The taxonomy provides a swift overview.*" (IE2) "*The taxonomy is intuitive to use, even more if supported by explanations.*" (IE9)
Fidelity with real-world phenomena	Demonstration, expert interviews	To validate the taxonomy in a naturalistic setting, the experts classified real-world objects of cooperative innovation projects involving their organisation. Upon finding that all these real-world objects could be classified, the experts confirmed the taxonomy's *fidelity with real-world phenomena*. More granular characteristics would enhance the mapping	"*The taxonomy can help to readjust formal design options.*" (IE1) "*Projects can be classified and can be compared, and gaps can be identified.*" (IE10)

Table 6 Details about the interviewees (continued)

Evaluation criterion	*Evaluation method*	*Interview results*	*Example quotations*
Applicability	Expert interviews	The experts also agreed that our taxonomy is applicable in practice (*applicability*), since it enables the structured classification of various cooperation forms. It was specified that the taxonomy would be a valuable tool to better conceptualise the course of a cooperation. Further, they confirmed that the taxonomy could function as a guideline to structure cooperation	"*I could image to apply the taxonomy as it provides a structured view of the cooperation.*" (IE2)

6 Discussion

6.1 Contribution

SMEs face limited capabilities to pursue innovation. Nevertheless, cooperation offers a spectrum of possibilities to accelerate and improve the ways innovations are developed. Consequently, selecting the right cooperation setup in a heterogeneous landscape of partners is crucial for innovation success and overall competitiveness. Despite the importance of cooperation for innovation to SMEs, literature lacks a structured overview of related key elements that hampers both scientific progress and clear-headed decisions for SMEs. We address this current lack of structure on cooperation for innovation, combining the different research streams on cooperation for innovation.

Since research into SME cooperation is spread across various facets (Baba et al., 2009; Hagedoorn et al., 2000), we have compiled key characteristics of cooperation for innovation via a structured methodological approach, deriving a taxonomy as the artefact. Thus, we focused not solely on a certain aspect of cooperation but condensed the topic's diversity and formalised it into a structured overview. Ensuring a proper theoretical foundation, the taxonomy builds on extant knowledge on key elements of cooperation for innovation derived from an SLR and combines general and IS specific innovation literature on this topic. We confirmed the taxonomy's usefulness and robustness by mapping 17 real-world objects, testing its practicability and contributing to the defined set of ending conditions and the taxonomy's maturity. In sum, we developed a taxonomy on the characteristics of cooperation for innovation of SMEs both inductively and deductively, following Nickerson et al.'s (2013) taxonomy development method. Our taxonomy encompasses 11 dimensions, namely, purpose, value-added, composition, partner source, direction, network range, timeframe, organisation structure, governance, information management, and communication.

Further, 10 semi-structured expert interviews validated our taxonomy as beneficial according to the proposed evaluation criteria, i.e., comprehensibility, understandability, ease-of-use, fidelity with real-world phenomena, and applicability. They as well applied the taxonomy for classifying own cooperation for innovation projects. In sum, our evaluation illustrates that cooperation in innovation differs significantly, as it depends on diverse external and internal contextual factors, such as incurable risk factors or the innovative pressure within the respective industry. Serving as a structuring tool for researchers in the investigated field and as a cooperation map for practitioners, our taxonomy provides a simple yet powerful tool to classify current cooperation for innovations and thus creating a more heterogeneous landscape of cooperation for single organisations.

6.2 Theoretical implications

Concerning theoretical implications, we have added to the descriptive knowledge on innovation for cooperation projects, increasing our understanding and establishing a foundation for higher-order theories (Gregor, 2006). The taxonomy enables the classification of cooperation for innovation and represents a theory for analysing (Gregor, 2006). First, our research presents the first in-depth conceptualisation of cooperation for innovation. Hence, the taxonomy contributes to theory building and is an essential prerequisite for further descriptive and prescriptive research (McKelvey, 1978, 1982; Posey et al., 2013). Our taxonomy provides a specification regarding the design space of cooperation for innovation and extends existing but nascent descriptive knowledge on cooperation for innovation.

Second, our research implies that various disciplines influence each other. Thus, the taxonomy relates to various research fields, including IS, innovation management, and organisational science (Glass and Vessey, 1995), and closes a theoretical gap in an interdisciplinary field. Our taxonomy emphasises that SMEs can highly benefit from discussing IS and innovation management in conjunction, as integrating digital topics into innovation efforts leads to innovation potentials for SMEs in creating solutions that are commercially viable (Frey et al., 2020). We understand our findings as a foundation for better managing the integration of diverse cooperation for innovation possibilities into an overall well-suited portfolio. Thus, we provide an impulse for more extensive scholarly focus concerning under researched areas of SME cooperation for innovation.

6.3 Managerial implications

Concerning managerial implications, our taxonomy has 11 dimensions that help to answer crucial questions when setting up cooperation for innovation in SMEs. First, we propose a classification scheme for SME practitioners to evaluate their efforts at the interaction between SMEs and possible cooperation partner. Thus, our taxonomy delineates the design options for practitioners and advises that one select organisation-specific parameters. With this taxonomy, practitioners can analyse their current cooperation projects, reconsider them, and gain knowledge to design new ways to cooperate that best suit their aims. For this purpose, we delivered key findings from a real-world database. Second, considering the expert interviews and real-world objects, cooperation is understood as an eligible strategy for promoting innovation. Moreover, our insights showed that cooperation for innovation is generally regarded as beneficial, as parties complement each other’s strength and weaknesses. Further, we demonstrated our taxonomy’s usefulness and practical relevance by applying real-world objects. The mapping shows that there can be no one-size-fits-it-all approach to SME cooperation for innovation, and the information on real-world objects may stimulate decision-makers to engage in new forms of cooperation and re-evaluate their existing cooperation projects. In sum, our results undermine that SMEs can be successful with fewer resources at hand in sharing and cooperating with other market participants in various compilations.

6.4 Limitations and outlook

This study has limitations. We describe the limitations and outline potential fields for further research. First, since cooperation is a field that offers many design options, we cannot guarantee to have covered all possible dimensions and characteristics. Thus, we argue that our taxonomy demands usefulness rather than completeness. Based on the evaluation results, this taxonomy can help practitioners to gain a better understanding of the aspects that underpin cooperation for innovation in the context of SMEs. Second, our research is based on applying real-world objects that we selected using convenience sampling, especially covering German and European real-world objects. Although our sample is not exhaustive and is limited regarding publicly available information, the sampling approach provided us with a sound basis of real-world objects. Further research could expand the database by integrating international real-world objects, which would provide insights to further enhance our proposed taxonomy. Because cooperation and its designs change over time, mapping additional objects in the future can also be used to prove the taxonomy's suitability. In a further research project, cooperation for innovation could be empirically evaluated using a cluster analysis, identifying typical combinations of characteristics. To our best knowledge, this is the first attempt to provide a structured overview of elements of cooperation for innovation in SMEs; we have laid a foundation for further prescriptive research into this topic.

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Appendix A: References of a structured literature review

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Appendix B: An overview over the cases

No	*Project name*	*Setting*	*Industry*	*Sources*
1	Forschungsvereinigung Antriebstechnik e. V. – FVA	203 organisations	Drive technology, automotive, mechanical engineering	AiF Arbeitsgemeinschaft industrieller Forschungsvereinigungen (2020)
2	Mondragon S. Cooperation	266 organisations	Diverse	Mondragon (2020) and Iturrioz et al. (2015)
3	Ruhrvalley Cluster e. V	104 organisations, research institutes, public institutions, and universities	Diverse	Ruhrvalley (2020) and Wolff and Nuseibah, (2017)
4	Aerogel	Empa and Fixit AG	Construction	Empa (2012)
5	Simplified Robotic Woodwork	7 organisations, 1 university, 1 association	Wood processing	Bundesministerium für Bildung und Forschung (2019)
6	Forschungsgemeinschaft für die kosmetische Industrie e. V. – FKI	4 SMEs and 4 larger organisations	Cosmetics	Forschungsgemeinschaft für die kosmetische Industrie e. V. (2020) and AiF Arbeitsgemeinschaft industrieller Forschungsvereinigungen, (2020)
7	Cashier services	Vectron Systems AG and DATEV eG	Information technology	Vectron (2019a)
8	Cashier services	Vectron Systems AG and rbNext Systems GmbH	Information technology and food service	Vectron (2019b)
9	Processing of special implants in dental laboratories	Datron and Sescoi	Dental technology	Datron (2013)
10	Ophthalmological solutions	Formycon and Santo Holding	Pharmaceutical products	Formycon (2013)

No	*Project name*	*Setting*	*Industry*	*Sources*
11	Joint treatment center	MagForce and Paracelsus Clinic Zwickau	Healthcare sector	Magforce (2019)
12	Wearable photometer	Tec5 and Hellma GmbH	Optics, measurement technology	Hellma (2019)
13	Sharing of image processing technology	Stemmer Imaging and Nanjing Inovance Industrial Vision Technology	Image processing	Stemmer Imaging (2018)
14	Joint competence center	Stemmer Imaging and Hochschule München	Image processing	Stemmer Imaging (2020)
15	EthaNa	Public institutions, research center, SMEs	Agriculture	EthaNa (2020)
16	CEMTOP	SMEs	Construction	CEMTOP (2020)
17	Nofima – CabbageTaste	Diverse	Agriculture	Nofima (2020) and Olsen et al. (2012)

Appendix C: References of a structured literature review

References: Second search (9 publications)

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