

Characteristics for Collaboration Types between Corporates and Startups

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Abstract – Established manufacturing corporates are facing major challenges today, as more and more technology-based startups are disrupting existing market competitors and are striving to gain foothold in new markets. Therefore, it can be observed that corporates and startups are increasingly seeking collaborations in order to gain advantageous access to resources, markets or even technologies from the respective partner. However, the majority of these collaborations fail for two reasons: first, the opportunistic choice of a collaboration type and, second, a poor suitability of established types of collaboration for technology-based startups. Consequently, the solution developed in this paper aims at addressing these problems by initially deriving a suitable collaboration framework based on strategic success potentials. Starting from identified requirements, a characteristic space for types of collaboration is determined. Based on this investigation, the paper shows which of the newly determined characteristics help fulfil strategically relevant success potentials of collaboration and, thus, enable a well-founded typification of collaboration types.

Keywords – Characteristics, corporate, determination of types, startup, successful collaboration, types of collaboration.

I. INTRODUCTION

Today, the market environment of many established corporates is characterised by increasing dynamics and high complexity in products as well as in the competitive environment [1], [2]. To be successful in this environment in the long term and to hold their position against emerging competitors, corporates are striving for innovations [1], [3]. However, these innovations in manufacturing are often based on new technologies, or entirely new, previously unidentified markets [4]. Correspondingly, it is yet difficult for corporates to implement these new-to-the-world innovations with their established structures [5]. At the same time, corporates are facing growing competition, which is primarily driven by emerging, technology-oriented startups [6]. Technology-focused startups identify niches and focus on areas outside the domination of corporates to establish themselves in new markets with technological innovations [7].

However, both corporates and startups face significant challenges in implementing innovation [8]. To overcome these challenges, they are increasingly often seeking collaborations and hope to gain access that they cannot tap themselves from the collaboration partner [9]–[11]. Corporates, on the one hand,

are striving for efficient access to technologies and markets that they can only develop themselves at great expense [12]–[14]. Technology-oriented startups, on the other hand, enter into collaborations with corporates to gain access to resources, capabilities and processes to facilitate company and market establishment [9], [13].

The acceptance of a collaboration between a corporate and startup manifests itself decisively in its type, which defines the coordination and outcome of the collaboration. Due to an insufficient knowledge base about suitable types of collaboration, however, these types are often chosen opportunistically in practice [15]. The opportunistic choice of the collaboration type causes the requirements of the dependent startups as well as the expectations of the corporates not to be met and, as a result, the collaborations fail to achieve their objective [16]. Reasons for the failure of collaborations between corporates and deep tech startups are, besides a lack of knowledge about existing types of collaboration, mainly missing types for the collaboration with startups as well as an inherent non-consideration of the specific requirements of technology-oriented startups [16]. In addition, it is becoming increasingly apparent that established types of collaboration are also not sufficiently suitable for achieving the corporates' objective of gaining access [14], [17] through collaboration with startups [18]. The lack of suitable collaboration types currently results in hardly beneficial collaborations between corporates and technology startups [16]. Following the motivation stated, the paper aims at answering the following research question:

Which characteristics are appropriate for typing collaboration between corporates and tech-based startups?

The paper is divided into six sections starting with the motivation in Section I. Section II introduces the chosen research methodology, whereas Section III points out relevant theoretical fundamentals. According to the raised research question and concluding the introduction, the fundamentals on collaboration between corporates and technology startups are presented first. This presentation facilitates the description and derivation of characteristics to derive suitable types of collaboration by choosing appropriate characteristic dimensions, while considering the specifics of corporates as well as technology startups. After a brief review of related work

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in Section IV, the elaboration of the solution approach, the determination of characteristics and the synopsis of a characteristic space to type collaborations are presented in Section V. Section VI concludes the research with a summary as well as an outlook on future research potentials.

II. RESEARCH METHODOLOGY

The paper focuses on a practical problem emerging from applied management and engineering science. Among the suitable qualitative approaches, process of applied science according to Ulrich is chosen for this paper [19]. Ulrich’s method of applied sciences consists of seven consecutive steps. The paper covers thereof five, while implementation and verification in industrial practice are not in the research focus.

The first section covers step A by describing the practical issue based on past and recent industrial practice. Section II and III cover step B by dealing with the hypotheses for the scientific approach and fundamental theories for the derivation of suitable types of collaboration. A brief review of related work represents step C and enables the discussion of established types of collaboration as well as problem-specific methods for the typification and the development of an applicable solution in Section IV. Subsequently, Section V frames the relevant context of application and the derivation of relevant assessment criteria and covers steps D and E by introducing relevant design requirements, the methodological approach as well as the solution for the underlying research question. Fig. 1 illustrates the chosen research approach.

Focus of this paper	A	Identification and typification of problems relevant to practice
	B	Identification and interpretation of problem-specific theories and fundamental sciences
	C	Identification and specification of problem-specific methods in formal sciences
	D	Derivation of assessment criteria, design criteria and methods
	E	Identification and examination of the relevant application context
▼		
Future research	G	Consulting and implementation in industrial practice
	F	Testing of derived criteria, rules and models in the context of application

Fig. 1. Method of applied science according to Ulrich.

III. FUNDAMENTALS OF COLLABORATION BETWEEN CORPORATES AND TECHNOLOGY STARTUPS

Following Ulrich’s approach of applied science, the theoretical fundamentals are presented in this section. The fundamentals cover the brief delimitation of corporates and startups, as well as theories for the emergence of collaboration and established types of collaboration.

A. Relevant Terms and Definitions

Corporates are characterised by the ability to exploit existing markets through an established product portfolio, structures and processes [20], [21]. Corporates operate in mature markets and pursue the goal of maintaining the status quo by increasing efficiency, improving quality, and reducing costs of existing processes [22], [23]. They are characterised by resources and

capabilities that favour beneficial use and incremental innovation [21]. Due to the difficulty of corporates to develop new technologies for still unknown, non-existent markets, the development of innovations is often the core of collaboration [24].

Startups are newly founded companies in search of a scalable, repeatable, and profitable business model [25]–[27] to sustainably establish themselves in a market [28]. Startups offer innovative products or services, in new business models [29] and have high growth ambitions, aiming to become a corporate in the long term [28]. They are characterised by extraordinary financial and resource needs [30], [31] which extraordinary often leads to the failure of tech startups [32].

Technology startups are startups that offer a physical product based on emerging or deep technologies, i.e., technologies at the very beginning of the technology life cycle [33], [34], with the potential for disruptive market changes [16]. They are founded by experts and emerge from a high-tech or medium-tech industry sector [16]. According to the literature, technology startups are characterised by the following characteristics: high technological uncertainty of their products [34], lack of resources and competencies for both product development and scaling [34], as well as the intention of forming new markets or disrupting existing ones [16]. Therefore, technology startups face an extraordinarily high risk of not succeeding to commercialize their product [35].

The term “collaboration” characterises the voluntary cooperation of at least two independent partners to achieve a common set of goals [36]–[38]. In this context, the pursuit of identical goals is not a necessary condition. It is possible for each partner to strive for their own, company-specific goals, if these goals are coordinated in such a way that they do not contradict each other [39], [40]. Despite having different goals, collaboration is initiated to obtain a higher degree of goal achievement compared to operating individually [37], [39], [41]. Collaboration can have a redistributive or reciprocal character, meaning the collaboration partners either pursue the same several goals together by adding up their resources (redistributive) or both collaboration partners pursue their own goals within the complementary support within the collaboration (reciprocal) [42].

B. Emergence and Explanation of Collaboration

The emergence of collaborations is highly dependent on the respective motivation of the collaboration partner. As literature shows, corporates enter into collaboration with startups to either gain access to technologies, products, markets or a combination thereof [11], [13], [43]–[46]. They do this to innovate and stay competitive, as the pressure on corporates to steadily offer new products in markets is increasing [47], [48].

The reasons for startups to enter collaborations differ greatly from the corporate reasons. Startups face several challenges, mainly caused by their young age, their rapid growth, and their uncertain and complex business environment [25]. Overcoming these challenges is the main motivation of deep tech startups entering collaborations. Due to the young age of startups, their customer and supplier relationships have yet to be built up and

maintained [49]. Caused by their smallness, startups lack financial, industrial, and personnel resources [50]. Developing deep tech products intensifies this challenge, as the development of technology is even more capital and time intensive than for other physical products. This makes it unlikely for a startup to survive a prolonged period of little economic success, especially since financing is more difficult for small companies than for established ones [25]. Additionally, startups that produce physical products usually do not have the necessary manufacturing facilities that would be required to scale quickly [51]. Lastly, technology startups operate in an extremely uncertain environment [28], [52]. Entrepreneurial decisions are therefore usually made under great uncertainty and associated with a high level of risk regarding market acceptance and the reaction of competition [25].

Besides entering a collaboration based on the motives and objectives, fundamental scientific theories are being used to explain the emergence of collaboration. According to the market-hierarchy continuum, collaborations offer potentials in terms of plannability and flexibility [53]. The explanatory theories based on new institutional economics [54] provide a suitable theoretical framework for the emergence of corporate-startup collaborations and are therefore described in more detail.

Central assumption of the transaction cost theory is that collaboration type is always to be preferred, whose transaction costs are minimal [55], [56]. Transaction costs are divided into information, agreement, completion, and adjustment costs [57], [58]. Here, not the costs of goods or achievements are described, but the developing transaction costs by the transfer of capital and goods underlying disposal rights [59]. Transactions can be differentiated depending upon specificity, strategic meaning, uncertainty, and frequency [54]. The risk of opportunistic behaviour increases with the degree of uncertainty of a transaction and its specificity [57]. Consequently, preventive measures such as sanctions or control mechanisms must be installed [60]. A large danger of opportunistic behaviour of a collaboration partner is to be met according to the transaction cost theory by the choice of a hierarchical transaction form [60].

The transaction cost theory distinguishes the collaboration from market and hierarchical co-ordination mechanisms, by describing collaboration as a hybrid form of co-ordination, which includes all interactions lying between market and hierarchy [57], [58], [61]–[63]. In this context, collaborations exhibit a certain degree of stability (called proximity to hierarchy), while remaining flexible for the partners involved (called proximity to market) [36].

The relational view initially described by Dyer & Singh states that resources can transcend company boundaries and be embedded in cross-company routines and processes [64]. Key success factors for realizing competitive advantage are the relational rents through collaborations [64]: investments in common resources, knowledge transfer, resource transfer, and a suitable institutional frame. Thus, the relational view provides

an explanation for the usage of third-party resources and the interaction between corporates and startups.

C. Types of Collaboration

Types of collaboration among companies (inter-firm collaboration) are widely explored and discussed in literature. To enable a critical discussion, selected characteristic types of collaboration shall be introduced shortly.

Strategic alliances can be described as a formalized, longer-term relationship among companies with the aim of compensating for their own weaknesses by leveraging the strengths of other organisations in order to secure or increase the competitive position of a company in the long term [58]. However, strategic alliances do not emerge in legally independent corporates [38], [65]–[67]. Strategic alliances are usually entered into on a horizontal level and, hence, between potential competitors [38], [65]–[67]. The inter-firm collaboration in a strategic alliance does not cover the entire value chain [65] but is usually limited to one or more subcategories of the functional areas [66], [68].

Virtual companies find their application especially in the field of research and development. These networks consist exclusively of legally and economically independent companies that operate on a project-oriented basis and therefore for a limited period using modern information and communication technologies [69]. The companies participate primarily within the scope of their core competencies and present themselves to the outside world, especially towards customers, as a unified company.

One must further differentiate between two types of joint ventures [38]: The equity joint venture and the contractual joint venture. In an equity joint venture, shares in a newly established independent company are held by the respective legally and economically independent collaboration partners [70], [71]. Constitutive attribute of the equity joint venture is the sharing of management and risk, whereby the ownership shares usually determine their respective extent [38]. In comparison to the equity joint venture, when establishing a contractual joint venture, no new corporate is founded, but rather is the collaboration stipulated in contracts [66], [72].

IV. REVIEW OF RELATED WORK

Building upon the identified challenges in practice (see Section I) and the chosen research methodology of this paper, related work in the context of types of collaboration is analysed. A summary of the analysis is presented hereinafter. The identified related work in this research area can be divided into two categories. On the one hand, work that deals with different types of inter-firm collaboration between corporates. On the other hand, work that describes types of collaboration between corporates and startups.

The literature on collaboration types mainly focuses on inter-firm collaborations between corporates. These collaboration types as, for example, described by Morschett, Baum, Ermisch, Keller and Friese focus on a long-term inter-firm collaboration [38], [73]–[76]. Whereas Morschett discusses the whole bandwidth of inter-firm collaboration, the author does not

present a uniform characteristic space for collaboration. Baum develops a typology and a model for of inter-firm collaboration. However, the author does not consider startups in his work. Similarly, Keller and Friese solely focus on inter-firm collaboration between established corporates. Although both authors describe some characteristic dimensions of collaboration, these do not sufficiently describe the characteristic space between corporates and startups. Only Ermisch specifically focuses on collaboration in research and development and, therefore, might partially fit the requirements of collaborations between corporates and deep tech startups. However, none of the considered approaches takes the asymmetry of collaboration partners into account or provides flexibility in changing the type of collaboration along the way.

Among the existing literature, collaborations between corporates and startups are predominantly described either from a corporate or a startups point of view, but not in an equal holistic way. The main goal of corporates to collaborate with startups according to the reviewed approaches of Jung, Weiblen & Chesbrough or Kohler [6], [11], [46] is the access to innovation. However, all these approaches describe the collaboration from a corporate's perspective and, therefore, prioritize characteristics suited to corporate's needs. Peter provides a framework, which comprises the focus on both the corporate and the startup. The author emphasises the selection of requirements dominated by the corporate, by providing detailed framework for the collaboration with startups [77]. Kurpjuweit & Wagner [78] analyse startups as suppliers of corporates and, thus, in the nature of things regarding supplier client relationships, focusing on the benefits of the corporate. The approach describes individual milestones in the establishment of a company as a requirement for a collaboration project but neglects a comprehensive investigation of the relationship between deep tech startup growth and the requirements for the design of collaborations [78]. Moreover, none of the above-mentioned studies take into account the characteristics of deep tech startups, describing existing collaboration types in unsuitable manner for collaboration between corporates and technology startups.

In conclusion, the presented analysis of existing literature on collaboration types shows that there is a theoretical lack of consideration regarding the typification of collaboration types between corporates and technology startups. The following five deficits are identified: first, the asymmetry of the collaboration partners is not sufficiently considered, and, thereby, especially the needs of the startups are not sufficiently met. Second, known types of collaboration are intended for the longer term and, therefore, are not suitable for organisational change that startups are going through along their life cycle. Third, the analysed collaboration types do not take a joint objective as the basis for collaboration. In fact, startups have the objective to build a new product under the uncertainty of a new market. Fourth, goals and motives of startups in collaboration are not sufficiently taken into account, so collaboration cannot solve the core challenges of startups. Based on these findings, a research deficit is identified regarding the nature of

collaboration between corporates and startups – especially in defining the relevant characteristics of collaboration types.

V. RESULTS

Answering the raised research question and building on the discussion of relevant literature, this section presents the model of this paper. For this purpose, requirements for the development of a solution and a suitable concept are presented first, before a suitable research method for the elaboration of the model is introduced, and, finally, the results are discussed.

A. Model Requirements and Rough Concept

Formal requirements are based on model-theoretical principles and serve as a basis for the development of models. The aim is to ensure the effectiveness and applicability of the model. According to Patzak, the empirical and formal correctness, the fit for the intended purpose, the manageability as well as the quality of the results are the main characteristics [79]. These characteristics are used as formal requirements in the present study.

Contextual requirements are derived from Section I as well as Section IV and serve as a framework for determining the characteristic space for collaboration types between corporates and startups. Since the contextual requirements are decisive for determining the characteristics, they are explained in a differentiated manner below.

Requirement I: The asymmetry between corporates and startups lies in the nature of the company size, available resources, and business experience [10], [80]. This results in a one-sided dependency on the part of the startup. Thus, collaboration types have to consider the fact that startups are smaller and at a disadvantage in initiating collaboration because they are dependent on external capital, from the corporate or VCs. The combination of different strengths of corporates and technology startups given by the asymmetry promises to be the optimal solution on the way to creating innovation for markets [81].

Requirement II: Due to the asymmetry between the collaboration partners, it is of importance that collaboration types consider both the goals of corporates and startups in a balanced manner. Because of the startup being the inferior partner, the individual goals of corporates and startups need to be considered equally when defining a collaboration goal. This can be realised by formalising a common goal, to which both corporate and startup are contributing their individual strengths. However, also both partners can bring in their individual goals and combine them in an additive manner.

Requirement III: Furthermore, collaboration types need to be easily and adaptively designed over time. Entering a collaboration, startups usually are in a certain life cycle stage. However, over time they often grow quickly and face new challenges. Due to this development, the goals of deep tech startups change as well. This can heavily impact collaboration. Thus, when reaching the initially aligned collaboration goal, the collaboration should give enough flexibility to redesign the goal and, therefore, steer the collaboration into another direction.

Requirement IV: Technology startups face the challenges of limited resources, unestablished business model and the lack of a sophisticated organisational structure. These challenges represent the major needs of startups when entering collaboration, e.g., access to resources, capital support and focus on exploitation. In this respect, the fourth contextual requirement describes the consideration of these startup needs as substantial for new collaboration types.

The contextual requirements indicate the need for a dedicated description of a feature space for the collaboration between corporates and deep tech startups. Hence, this paper conceptually adopts the following procedure for the initial determination of the characteristic space: definition of a suitable scientific approach for the elaboration of a feature space (1); identification of success potentials of the collaboration partners to determine the goals for the collaboration (2); determination of suitable characteristics to build a feature space for types of collaboration between corporates and deep tech startups (3); description of the feature space (4).

B. Analytical Research Methodology Typification

The objective of the present research is the identification of characteristics. For the identification of characteristics, the application of a systematic approach is necessary. Among analytical research methods, typification, classification, and the morphological method are the three distinctive common approaches. The analytical research methods pursue the goal of a descriptive systematization of an area of investigation [82]. Whereas a classification requires one feature for the description, a typification requires at least two potential features [83]. The morphological method presupposes that also at least two potential features are available for the description of an object of investigation. Typification aims at capturing real observable expressions of features [83], the morphological method aims at capturing all logically possible combinations of features [84]. Since this paper aims at investigating and abstracting real observable collaboration types, the research method typification is applied.

According to Welter and Knoblich, the typification procedure is structured in five consecutive steps [82, 83]. The paper focuses on the determination of meaningful characteristics and identifies the relevant attributes for collaboration between corporates and startups.

C. Derivation of Strategic Success Potentials for Collaboration

The analysis of the related work and the derived contextual requirements indicates that the determination of suitable types of collaboration for corporates and startups cannot be based solely on the selection of existing collaboration characteristics. Rather, following the first step of the methodology of typification, it is necessary for the scope of the research while taking the contextual requirements into account. To this end, it is advisable to start by thinking in terms of the goal of the collaboration.

Corporates and technology startups enter collaboration for different reasons, both expecting the collaboration to be successful. A collaboration is considered successful if the goals are achieved. Therefore, it is necessary to initially define

collaboration goals in order to describe the success of collaboration. According to Wohlge-muth & Hess, the success of inter-organisational collaboration can be determined in two ways [40], which are the cumulative and the collective determination of inter-organisational success. The cumulative method implies that the overall goal of the collaboration consists of an accumulation of the individual goals of the respective collaboration partners [40]. In contrast, the collective method is based on the joint determination of shared goals by the collaboration partners [40]. The collective determination of success can only be carried out during the collaboration, whereas cumulative determination of success is possible both ex ante and ex post [85]. For this reason, the cumulative approach will be used below to determine success in collaboration between corporates and startups.

Literature states that, in general, both corporates and startups are willing to achieve competitive advantage through collaboration [40], [86]. Competitive advantages result from the successful exploitation of success potentials. Thus, to determine specific, individual goals of the collaboration, the concept of success potentials is applied.

In order to survive in the long term, companies must be economically successful. They can accomplish this by realising competitive advantages, which in turn depend on the exploitation of their success potentials. Following Binder & Kantowsky, the concept of success potentials originates from strategic management, where the task is to seek, build up and maintain sufficiently high and reliable success potentials [87]. Thus, according to Ringle, the successful exploitation of success potentials enables the achievement of competitive advantages [86]. However, since corporates and startups can only realise their competitive advantages individually, the success potentials represent suitable individual, specific goals for collaboration between corporates and deep tech startups. In addition, the availability of capabilities and resources is the basis for success potentials [86]. These capabilities and resources are exchanged within the reciprocal collaboration between corporates and deep tech startups, where corporates and startups each seek access to the capabilities and resources that they lack. In the following section, the success potentials of corporates and technology startups are derived in an explorative manner. An overview of the derived success potentials is presented in Fig. 2.

Determination of Collaboration Success			
Collaboration partner	Success potentials		
Startup success potentials	Technological uncertainty (1)	Uncertainty of business development (2)	Uncertainty of scaling & commercialization (3)
Corporate success potentials	Technology access (1)		Market access (2)

Fig. 2. Success potentials of corporates and deep tech startups as guiding goals for successful collaboration.

Success Potentials of Technology Startups

The analysis of relevant literature on the motivation of startups to enter collaborations shows that they do this to overcome the challenges implied by their newness, their smallness, and their volatile market environment: Due to their newness, startups require a considerable amount of time to develop new procedures, as processes and tasks are not yet standardized [49], [74], [88]. Furthermore, relationships with customers and suppliers must first be established and a basis of mutual trust needs to be established [25], [49], [74]. The smallness of startups leads to a lack of financial, physical and human resources meaning that startups have difficulty accessing external funding and do not have the industrial facilities and human resources to scale their production [25], [50], [89]. In addition, technology startups operate in an extremely uncertain and complex technological environment. Decisions are therefore usually made under great uncertainty and are associated with a high level of risk. There are significant risks with regard to market acceptance and the reaction of competitors to new products [25], [28], [52].

Considering the characteristics of technology startups, the main challenges faced by technology startups can be condensed to the following three. First, due to the novelty of the technologies applied, it is uncertain that product development will lead to a market-ready product at all. Second, novelty of the technologies as well as the lack of resources causes uncertainty about whether a market for the product can be developed at all and whether a successful business can be established within this market. Third, even if product development leads to a market-ready product, the lack of financial resources and access to production capacity makes it uncertain whether successful scaling and commercialization can be achieved. Therefore, overcoming the *technological uncertainty*, the *uncertainty of business development* and the *uncertainty of scaling and commercialization* are the three success potentials of technology startups entering collaborations with corporates.

Success potentials of corporates

The goals of corporates to enter into collaboration are widely explored and discussed in the existing literature [38], [53], [90], [91]. Having analysed the literature, these goals can be summarised into the following five: cost advantages, entering new markets, quality advantages, risk reduction, and technology access [38, 90, 91].

Corporates often struggle with high fixed costs, which can be reduced within collaboration through economies of scale in the course of volume expansion [90]. Due to the above-mentioned scaling difficulties as well as the lack of resources of startups, it is not possible to gain cost advantages by collaborating with technology startups. Quality advantages are an important factor for differentiating the company's performance and, thus, for gaining competitive advantages. Collaborations offer a wide range of possibilities for realising quality advantages. For example, quality advantages can be achieved through collaboration in the areas of market research, product development and production. [38] However, since technology startups do not yet have products in the market, they lack the

necessary experience and standards to enable quality advantages within collaborations. Corporates also enter into collaboration for the purpose of risk spreading. This means they try to build up a broad and diversified portfolio through collaboration [90]. However, this is not possible in collaboration with deep tech startups, as startups are at a high risk of failure. Ultimately, two collaboration goals remain: the access to a new market and the access to technology. Technology startups can offer exactly those: their technology and the access to markets. Therefore, market access and technology access are the success potentials of corporates in collaboration with technology startups.

D. Common Characteristics for Collaboration between Corporates and Startups

For the elaboration of relevant characteristics, suitable design characteristics of established inter-firm collaboration types are identified and outlined in the following section. The identified design characteristics of inter-firm collaboration comply with the contextual requirements to ensure the suitability to the specific collaboration type between corporates and startups.

Initially, the contextual requirements constitute the framework inside which design characteristics for collaboration are identified. In the process of research for this paper, a comprehensive literature review regarding design characteristics for corporate startup collaboration was carried out. An extensive literature analysis of inter-firm collaboration indicated a long list with 23 potential design characteristics (see Appendix A), which address different aspects of collaboration. To determine the problem-focused characteristic space of collaboration design between corporates and deep tech startups, the characteristics identified above must be rated according to their relevance for the contextual requirements.

The evaluation and rating of the identified potential design characteristics are carried out by means of the consistency analysis according to Weimer-Jehle [92]. It is used to eliminate redundancies of the design characteristics in order to ensure compliance with the formal requirements. The consistency analysis aims at analysing the interdependence of the identified design characteristics and is presented in Appendix A. The consistency analysis is carried out in an undirected form, meaning that the causal direction between the design characteristic is not relevant. Based on the individual dependency values, a measure of the combination-theoretical dependency of the design characteristics under consideration results from the column-by-column summation. The result of this analysis represents those characteristics of collaboration which, according to the evaluation, are also suitable for collaboration between corporates and technology startups.

According to the consistency analysis, there are three major categories of design characteristics: one group with a low scoring (scores 1–3) indicating a low combination-theoretical dependence, the second group with a medium scoring (scores 4–7) indicating a significant dependence on collaboration types and the third group of highly dependent design characteristics (scoring above 8). Given the underlying research question and the formal requirements of manageability and usefulness, it

appears sensible that only the group of those that show a high degree of dependency should be considered. In this way, unfocused development of the characteristic space is prevented, and applicability is preserved. Fig.3 illustrates the characteristics for the determination of collaboration types identified in this way and their corresponding characteristic values. In the following section, these are briefly presented and characterised in detail.

Emerging from the consistency analysis, the high dependency of the design characteristic *resources* shows its outstanding importance for collaboration types between corporates and startups. The design characteristic aims at describing the main type of resources, which are exchanged between corporates and startups in collaboration. The characteristic values distinguish between tangible, intangible, financial and human resources. *Tangible resources* include all physically available and tangible resources. These include, for example, technical production facilities, buildings and vehicle fleet, as well as raw materials [93]. *Intangible resources* are immaterial assets, for example, patents for newly developed technologies or licenses to use these technologies [94].

Human resources are characterised by the competencies, skills and qualifications of the employees. Human resources also include factors that are difficult to measure, such as the experience or relationships of employees [93]. *Financial resources* are to be differentiated into equity and debt capital according to their source of funds. While equity capital refers to the ownership structure and resulting voting rights of a venture, debt capital in the form of loans justifies the lender's interest claim [94].

Following the design characteristic *resources*, the design characteristic *resource linkage & competence transfer* describes how the capabilities and resources are exchanged within collaboration. A distinction can be made between complementary and additive collaboration. The *complementary collaboration* structure is characterised by the pooling of resources of both cooperation partners to achieve a common goal [95]–[97]. This structure is also known as reciprocal collaboration. In contrast, in the *additive collaboration* structure, also known as redistributive cooperation structure, different but complementary resources are exchanged to achieve individual goals [95]–[97].

The goals pursued in collaboration are manifold and differ depending on the collaboration partners. Both collaboration partners pursue a *goal* that would be much slower or impossible to achieve without the collaboration [98]. As the success potentials describe the context of the goals, the type of goal indicates the effect which shall be achieved in collaboration. The various goals can basically be assigned to two different groups according to Dyckhoff & Ahn [99]. A distinction can be made between an *objective goal* and a *formal goal*. While the objective goal aims at a certain change of state (effectiveness), the formal goal describes how quickly this change of state is achieved (efficiency).

Design characteristics	Potential characteristic values			
	Resources	Tangible	Intangible	Financial
Resource linkage & competence transfer	Complementary collaboration		Additive collaboration	
Goal	Objective goal (effectiveness)		Formal goal (efficiency, economy, speed)	
Capital investment	No investment	Minority investment (<50%)	Investment at par (both 50%)	Majority investment (>50%)
Legal form	Non-contractual agreement	Contractual agreement without capital involvement		Contractual agreement including capital involvement
Direction of collaboration	Horizontal		Vertical	Diagonal
Initial objective	Outside-in		Inside-out	

Fig. 3. Initially identified design characteristics of collaboration.

In the literature on collaboration, *capital investment* in the narrow sense refers to the participation of two collaboration partners in a third, legally spun-off joint venture [97], [100]. The amount of the equity shares usually reflects the ownership and control rights of the respective partner [38]. Considering the scope of this paper, equity participation is extended to unilateral or mutual participation of corporates and deep tech startups. The extent of capital participation in the startup can range from 0 % to 100 %. Thus, the following distinction is applied: no capital investment, minority capital investment, parity capital investment and majority capital investment [91], [96], [97]. *No equity participation* exists if no equity shares in the start-up have been acquired [91]. If the equity stake is greater than 0 % and less than 50 %, it is referred to as a *minority stake* [91]. If a third joint enterprise is founded by two independent partners, this can be owned 50 % each by both collaboration partners, which is referred to as a *parity participation* [101]. A *majority shareholding* exists if the equity shares are higher than 50 % [91].

Besides the characteristics referring to the goal and capital investment, the *legal form* within the collaboration needs to be considered. Non-contractual agreement, contractual agreement without capital involvement and contractual agreement including capital involvement can be distinguished [38], [75]. A *non-contractual commitment* is the rarest form, because the renunciation of any formal basis leads to regulation by the prevailing legal system and, if necessary, by social rules. Legal claims and obligations, thus, exist, but their enforceability in the context of collaboration is questionable [41]. In contrast, contractual agreements are far more common in practice [73]. *Contractual agreements without capital involvement* are less binding and intensive than those with capital interdependence [38]. *Capital involvement* describes the establishment of an independent company by the collaboration partners or the unilateral or mutual capital participation [102].

To further describe collaborations between startups and corporates, the *direction of collaboration* plays a crucial role. The direction can either be horizontal, vertical, or diagonal.

Collaborations between companies at the same stages of the value chain are referred to as *horizontal* [103]. This may well involve potential competitors [97]. *Vertical* business collaboration involves the collaboration of companies that belong to successive value creation stages [38]. It is therefore possible, but not necessary, that these companies are in a supplier-customer relationship [78], although not every supplier-customer relationship is a vertical collaboration [104], [105]. *Diagonal* collaborations are characterised by the fact that the respective partners neither belong to the same nor to successive value creation stages and therefore operate in different business areas [38], [103], [106].

The characteristic of the *initial focus* describes the transfer direction between the two collaboration partners. According to Steiber et al. [8], a distinction can be made between outside-in or inside-out. The characteristic *outside-in* describes that the initial focus of the collaboration is for the corporate to learn from the startup. This can be done by bringing startups into contact with individual departments of the corporate [8], [77]. In contrast, the characteristic value *inside-out* states that the initial focus of the collaboration is the exploitation of the knowledge of the corporate by the deep tech startup. This can take place, e.g., through the establishment of an accelerator program, which enables the startup to further mature the product and business model through the corporate [8], [77].

Overall, the presented characteristics comply with the contextual requirements and focus on the second step of typification. Thereby, the identified attributes enable the description of a characteristic space for collaboration types. However, all design characteristics described emerge from existing literature and are specified for collaboration in general.

E. Discussion of the Characteristic Space for Collaboration between Corporates and Deep Tech Startups

A sole identification of established characteristics of collaborations does not answer the raised research question conclusively. Moreover, the suitability of the previously identified characteristic attributes as well as the success potentials needs to be elaborated. The aim of the following discussion is the derivation and summarisation of the findings in terms of an initially derived characteristic space for collaboration.

To ensure compliance with the second contextual requirement, which demands taking the goals of both corporates and deep tech startups into account, the identified success potentials need to be integrated in the characteristic space. This furthermore enables the cumulative determination of collaboration success, as the goals of both collaboration partners are considered. Consequently, the success potentials (Section V.C) are supplemented with the design characteristics and their potential characteristic values identified in Section V.D and, thereby, complete the characteristic space. In total, this results in a characteristic space consisting of nine design characteristics with a total of 25 possible characteristic expressions for the determination of collaboration between corporates and technology startups. Fig. 4 presents the

developed characteristic space as well as the identified characteristics and corresponding expressions.

Design space characteristics		Potential characteristic values			
Success potentials	Success potential corporate	Market access		Technology access	
	Success potential deep tech startup	Technological uncertainty	Uncertainty of business development		Uncertainty of scaling & commercialization
Design characteristics of collaboration	Resources	Tangible	Intangible	Financial	Human
	Resource linkage & competence transfer	Complementary collaboration		Additive collaboration	
	Goal	Objective goal (effectiveness)		Formal goal (efficiency, economy, speed)	
	Capital investment	No investment	Minority investment (<50%)	Investment at par (both 50%)	Majority investment (>50%)
	Legal form	Non-contractual agreement	Contractual agreement without capital involvement		Contractual agreement with capital involvement
	Direction of collaboration	Horizontal	Vertical	Diagonal	
	Initial objective	Outside-in		Inside-out	

Fig. 4. Overview of design space characteristics for the determination of collaboration types between corporates and deep tech startups.

VI. CONCLUSION AND FUTURE RESEARCH

This paper presents a characteristic space for determining types of collaboration between corporates and startups. To answer the research question raised, a solution concept was developed that includes the identification of success potentials of collaboration between corporates and startups on the one hand and the identification of design characteristics from the literature on the other hand. While the success potentials enable a cumulative determination of collaboration success, the identified design features represent a synthesis of established forms of collaboration. Consequently, the derived feature space includes both the success potentials and collaboration characteristics that represent a high relevance for the collaboration between corporates and startups. Nonetheless, types of collaboration cannot be derived from the feature space without a further methodological approach.

Accordingly, this also highlights the fact that this study is only the starting point for determining types of collaboration between corporates and startups. Initially, it needs to be investigated by an explorative study, where combinations of characteristics values can occur simultaneously. These combinations need to be included or excluded, respectively. Future research must also identify which characteristics can be conceived as type-forming and which are merely type-descriptive. Hereafter, it requires the formation of types based on the characteristic space as well as their validation in practice. Since the present paper does not yet allow for conclusions to be drawn about the number of types that are sufficiently necessary, future work must first allow for the identification of type-forming features and then use a reduction to reasonably narrow down the number of types. In the course of this process, the

identified characteristics must be checked for their applicability and adapted if necessary. The determination of types of collaboration between corporates and startups is part of an ongoing Doctoral Thesis project and therefore critically selects the results of this work.

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APPENDIX

Legend

[1] - design characteristic in row i in direct correlation with design characteristic j in column j

[0] - design characteristic in row i without direct correlation with design characteristic j in column j

	i \ j	C 1	C 2	C 3	C 4	C 5	C 6	C 7	C 8	C 9	C 10	C 11	C 12	C 13	C 14	C 15	C 16	C 17	C 18	C 19	C 20	C 21	C 22	C 23
Division of labor	C 1	1	0	1	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0
Type of licensing	C 2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0
Type of resources	C 3	1	0	1	1	1	1	0	1	0	1	0	1	0	0	0	1	1	1	0	1	1	0	0
Resource Linkage & Competence Transfer	C 4	1	0	1	1	1	1	0	0	0	1	0	0	0	0	0	1	1	1	0	0	1	0	0
Type of knowledge transfer/intellectual property	C 5	1	0	1	1	1	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Type of goal	C 6	0	0	1	1	1	1	0	1	1	0	0	1	1	0	1	1	0	0	0	0	0	0	1
Duration and time horizon	C 7	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0
Functional areas	C 8	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0
Geographical scope	C 9	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Initial focus	C 10	1	0	1	1	1	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	1
Degree of institutionalisation	C 11	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	0	0	0
Capital investment	C 12	0	0	1	0	0	1	1	0	0	0	1	1	0	0	1	1	0	1	1	0	0	0	0
Collaboration management	C 13	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0
Collaboration type	C 14	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0
Learning philosophy	C 15	1	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0
Marketing	C 16	0	0	1	1	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0
Legal form	C 17	1	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	1
Direction of collaboration	C 18	0	0	1	1	0	0	0	1	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0
Form of transaction	C 19	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Scope and intensity	C 20	0	1	1	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Corporate function	C 21	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Value capture	C 22	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Target level	C 23	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
Number of dependencies on characteristic j		6	4	12	9	6	10	3	5	3	8	4	9	5	2	5	6	9	9	4	6	3	1	3
Division of labour																								
Type of licensing																								
Type of resources																								
Resource Linkage & Competence Transfer																								
Type of knowledge transfer/intellectual property																								
Type of goal																								
Duration and time horizon																								
Functional areas																								
Geographical scope																								
Initial focus																								
Degree of institutionalisation																								
Capital investment																								
Collaboration management																								
Collaboration type																								
Learning philosophy																								
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Legal form																								
Direction of collaboration																								
Form of transaction																								
Scope and intensity																								
Corporate function																								
Value capture																								
Target level																								

Appendix A. Consistency analysis for the identification of relevant characteristics for collaboration [8], [27], [38], [53], [66], [71], [75], [90], [91], [95]–[98], [100], [102], [107], [108]