publish-Ing.

Journal of Production Systems and Logistics
Volume 2 | Article 7
Published: March 2022

Description Approach for the Transfer of Competencies and Resources in Collaborations Between Corporates and Deep Tech Startups

Günther Schuh [1,2], Bastian Studerus [2], Aaron Rohmann [2]

[1]*Laboratory for Machine Tools and Production Engineering (WZL), RWTH Aachen University, Aachen, Germany*
[2]*Fraunhofer-Institute for Production Technology IPT, Aachen, Germany*

Abstract

Deep tech innovations and emerging competitors are putting increasing pressure on established companies to defend their competitive position in globalized markets. With the aim of efficiently generating deep tech innovations through access to deep technologies and thus ensuring growth, corporates are increasingly entering into collaborations with deep tech startups. For their part, deep tech startups are seeking access to complementary competencies in collaborations with corporates. However, due to their differences in practice both partners often lack an understanding of transferable competencies and resources, e.g., deep technologies, competencies, and resources. In the context of this work, a model to characterize and identify the potentials for complementary transfer of competencies from corporates and startups within a collaboration is elaborated. Based on an organization-theoretical delimitation of the collaboration partners, a morphology is developed that characterizes suitable groups and dimensions for the identification of competencies and resources. For this purpose, existing approaches for the exchange of competencies in collaborations are analysed and the deficits in relation to deep tech startups are discussed. Based on this, superordinate groups are derived that consider the specific characteristics of corporates and startups. The morphology enables the description of the competencies and resources within a collaboration between corporates and deep tech startups.

Keywords

Deep Tech Startup; Corporate; Competencies; Resources; Transfer; Technology Access; Deep Tech

1. Introduction

New competitors, changing customer needs and disruptive technological developments have transformed the business environment of corporates in recent years [1]. Newly founded and highly innovative deep tech startups enter the stage with the aim of exploiting untapped market niches [2] and, thus, put corporates under great pressure by exposing their technological limits [3]. Instead of focusing on the exploration of technological innovations, the organizational structure of corporates is primarily designed to maximize efficiency, improve quality while at the same time reducing costs of existing processes to maintain their global competitiveness [4]. In order to cope with the speed as well as the radical nature of innovations, and to exploit technological opportunities to develop novel products and business models, which lie outside their core activities [5], corporates are increasingly seeking strategic access to these innovations through collaborations. This access is typically provided by startups with a distinctive technological core - a deep technology. Deep tech startups strive to scale to become corporates one day and thus rely on the successful development of their deep technologies [6]. However, the development represents a major challenge due to the insufficient availability of competencies and intangible resources (e.g., know-how, market access, market approval) [6]. In order to overcome these deficits, deep tech startups are therefore increasingly entering into

This Paper has been reviewed by the Certified Reviewer Community of publish-Ing. – 2 reviews – double blind

DOI: https://doi.org/10.15488/11860
ISSN: 2702-2587

collaboration with corporates [7]. Deep tech startups in particular can benefit from the competencies and resources of corporates in the high-tech or medium-high-tech sector[1] [8]. However, due to the diversity of requirements and inexperience in the explication of offer and supply, collaborations fail in practice because of the unsuccessful transfer of competencies and resources [9,10]. A competitive advantage can hardly be gained from collaboration and both partners fail to achieve their innovation goals [11]. In order to enable a successful transfer of competencies and resources in collaboration for both parties, this paper pursues the following research question:

How can competencies and resources, which are relevant for a transfer in a collaboration between Corporates and Deep Tech Startups, be identified and characterized?

To answer the arising research question, this paper is structured in six consecutive sections. Whereas section 1 motivates the practical problem and indicates the research needs, section 2 introduces the applied research methodology. In section 3, the theoretical fundamentals form the basis for a literature review in section 4. This review elaborates the deficits of existing approaches and enables the derivation of requirements in section 5. Following, the development of a morphology to identify relevant, transferable competencies and resources in collaborations is discussed. Section 6 concludes the research paper by giving a short conclusion as well as an outlook on future research.

2. Research Methodology

Due to its proximity to the engineering science and its interdisciplinary and comprehensive practical approach, the methodology of applied sciences according to ULRICH is applied for the present work [12]. Considering that the exchange of competencies and resources in interorganizational collaboration represents a problem from industrial practice, an application-oriented approach is chosen as research methodology.

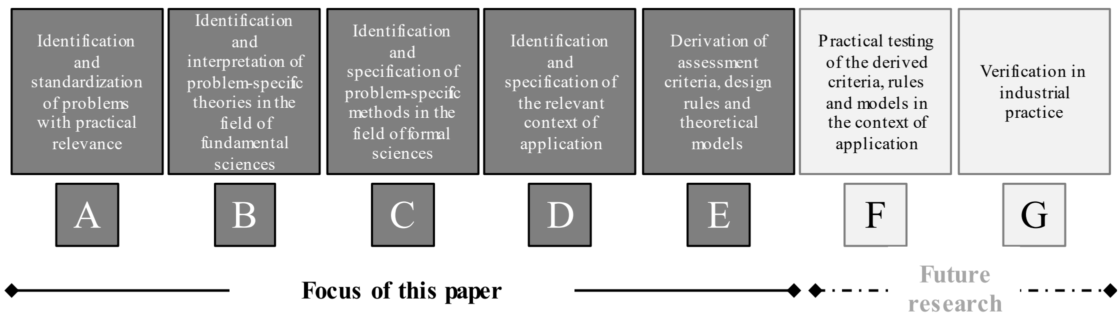


Figure 1: Research process according to ULRICH [12,13]

ULRICH defines seven consecutive process steps as illustrated in Fig. 1, of which steps A to E are dealt with in this paper [13]. By addressing the increasing importance of collaborations between corporates and deep tech startups and introducing the reader to the subject of the study, the first section covers step A. Step B is covered in section 2 and 3 by developing a common theoretical understanding of the study object. Subsequently, section 4 investigates existing approaches for the characterization of competencies and resources in companies as well as in collaboration and briefly discusses their deficits (step C). Finally, requirements are derived, thus, setting the framework for the design of a model (step D). Step E is covered by section 5, presenting the morphological approach, and discussing the morphology development for the characterization of competencies and resources in collaborations between corporates and deep tech startups.

1 OECD (2011). *ISIC Rev.3 Technology Intensity Definition.* OECD. [14.10.2021] Retrieved from https://www.oecd.org/sti/ind/48350231.pdf

3. Theoretical Background

The following section briefly introduces and defines relevant terms from the field of organization theory and new institutional economics. To begin with, the terms corporate and deep technology startup are defined to create a common understanding of both types of organizations. Second, motives for entering collaboration will be elaborated by introducing relevant theories from new institutional economics.

3.1 Characteristics of Corporates and Deep Tech Startups

Corporates have the resources, power, and the required know-how on how to execute a scalable business model. Deep tech startups offer highly innovative and disruptive ideas, organizational agility, and their willingness to take risks to achieve rapid growth [5]. Because of the big disparity between corporates and deep tech startups the following sections outlines the distinctive characteristics of both organizational forms.

3.1.1 Corporates

In this paper, the term **corporate** defines an organization which is in the maturity stage of its organizational life cycle and is pursuing the exploitation-oriented implementation as well as scaling of established business models [14,15]. Thereby, corporates are able to access a pool of different resources, such as various types of human capital, associated intellectual property, financial resources, and an extensive network to key stakeholders (e.g., suppliers, customers, legislators) [16]. Due to their typically long historical background, corporates are capable of providing a high level of reputation as they have already made their mark within their respective industry [4]. However, for the efficient realization of strategic goals, corporates increasingly enter collaboration to close their own competence and resource gaps through the targeted transfer [7].

3.1.2 Deep Technology Startups

A **deep technology startup** (short: **deep tech startup**) is composed of the term's deep technology and startup. Even though deep technologies are widely prevalent in industry and government, to date, no commonly accepted definition of the term deep tech exists in literature [3]. In fact, it encompasses multiple and ambiguous characterizations from academics and practitioners, which raises the need to compile existing explanations and align the meaning of deep tech in the context of this research.

At its nucleus, it can be stated that deep tech defines a type of technology at a very early stage of its technology life cycle [3,17]. Accordingly, successful deep technologies represent reinterpretations of fundamental technological capabilities with the potential to create entirely new markets and solve major societal and environmental challenges [3,8,18]. These technological solutions can be found today in fields like artificial intelligence, advanced materials, biotechnology, blockchain, robotics and drones, photonics and electronics, and quantum computing [3]. Industrial areas of application can be identified among others in healthcare, agriculture, energy use and storage, manufacturing, and consumer goods and services [18]. Despite their high innovation potential, deep tech can be distinguished from other technology classifications by their associated risks and requirements for successful realization. SINCLAIR defines deep technologies as a type of technology that is associated with high technological risk because technological implementation may not be feasible [3,17]. DENOO ET AL. add up an associated market risk, as deep tech may be too advanced to find market application [17]. In light of the presented risks, the realization of deep tech requires a strong research base, large amount of funding and is characterized by a long time to reach market maturity [8,19].

According to GIARDINO ET AL., **startups** can be defined as young companies which pursue the exploration-driven implementation and scaling of novel business models in a business environment of extreme uncertainty [20]. Its purpose is the creation of new products or services along with the primary ambition of rapid company growth stated by RIES [21]. Instead of an efficiency-oriented organizational structure, according to WEIBLEN AND CHESBROUGH, startups are characterized by their agility, flexibility, and innovative corporate culture [5]. However, due to their liability of newness and smallness [22], startups face a general scarcity of resources which makes them highly dependent on external support (e.g., funding) [23]. This is especially true for manufacturing startups, which require largely greater sums for producing prototypes and later on scaling the production for commercialization [24]. Furthermore, manufacturing startups lack skills and know-how scaling complex, yet, unique production processes [24].

Unifying existing literature on deep technologies and manufacturing startups, for the purposes of this paper, the term deep tech startup is defined as:

"A deep tech startup is a newly found enterprise with a physical key offering that needs to be manufactured and that is based on a systemic innovation with the potential for disruptive market changes. Deep tech startups originate from an industry focus in high-tech or medium-high-tech sector and an essential expertise of the founding team in deep technologies."

Subsequently, a deep tech startup can be characterized by the following characteristics. First, deep tech startups face a high technological risk, as deep technologies are based on a true technological innovation and, technological feasibility may not be guaranteed [17,25]. Second, deep tech startups are confronted with high investment needs in terms of extensive access to resources and competencies (e.g., funding, business and technical know-how, access to facilities) to successfully develop deep technologies [8]. Third, they face a high risk of proving market demand and, thus, commercial application might not be given [17]. Moreover, deep tech startups are characterized by their challenging industrialization process of deep tech products comprising hardware, which require a set of industrial competencies to procure, manufacture and scale [8].

3.2 Competitive Advantages through Collaboration

Collaboration between corporates and deep tech startups can be defined as a voluntary agreement between two independent partners working together to achieve business goals more efficiently [26]. As PICOT AND WOLFF developed, the **transaction cost theory** states that the form of coordination should be preferred whose transaction costs are minimal [27]. In this context, transaction costs refer to all costs that arise from the exchange of property rights associated with goods or services between two partners [28]. Eventually, the transaction cost theory describes a market-hierarchy dichotomy and, thus, represents a valuable explanatory approach for the emergence of collaborations [29,30]. Thereby, collaboration can be seen as a hybrid form of coordination that has a certain degree of stability (proximity to hierarchy) and at the same time flexibility for the partners involved (proximity to the market) [27]. The **resource-based view** states that the success of a company is significantly influenced by the availability and utilization of resources [31]. According to DAFT, resources are defined as all assets, capabilities, organizational processes, information, know-how, reputation, etc. controlled by a firm [32]. Referring to the resource-based view, a company generates a competitive advantage if it has key resources and uses them efficiently [33]. Since a company cannot have all resources it needs itself, collaboration is a suitable way of ensuring access to missing resources [34]. The **relational view** represents an explanatory approach which builds on the transaction cost theory and the resource-based view [35]. It states that companies can achieve a competitive advantage through collective rather than individual action by bundling resources and competencies in an appropriate organizational framework [34]. DYER, SINGH AND HESTERLY define four essential success factors to achieve competitive advantages within the scope of a collaboration - investments in common resources, knowledge transfer, resource transfer, and a suitable institutional frame [36].

3.3 Competencies and Resources in Collaboration

The concept of organizational competencies can be viewed differently within an organization. From a strategic management perspective, competencies can be defined as a combination of resources and capabilities [37,38]. The presence of competencies, thus, implies having the required know-how and skills to successfully utilize the tangible resources of a company in an economic way to earn a competitive advantage [39]. As such, (core) competencies can be a source of strategic competitiveness and, thus, represent an important subject of collaboration [40]. In the context of this work, the term resource only refers to the availability of tangible (e.g., equipment, capital, or facilities) and intangible resources (e.g., reputation) of a company which can be shared or transferred in collaboration [41]. Competencies in the context of this paper are understood as intangible know-how to use tangible, financial or organizational resources.

4. Literature Review

The following section presents problem-specific shortcomings in literature to derive requirements for the subsequent model development. Thereby, the focus of the literature review rests on two areas. First, established approaches for the identification of competencies in companies are presented. Second, existing approaches for the identification of transferable competencies and resources in collaboration are reviewed.

4.1 Approaches for the Identification of Core Competencies

In literature, a variety of approaches for the identification of (core) competencies can be found, each with a different focus. One of the first and best-known approaches was developed by the authors PRAHALAD & HAMEL which laid the cornerstone for the *Core-Competency Approach*. As an initial literature screening revealed, the approaches of PRAHALAD AND HAMEL [40], TAMPOE [42], and STEINLE ET AL. [43] are suited to identify core competencies of corporates and startups and therefore will be presented in the following.

PRAHALAD AND HAMEL's approach is based on the idea that every company can be represented by a portfolio of business units and (core) competencies [40]. For the identification of core competencies and the derivation of strategic recommendations for action, the authors propose a holistic allocation of all resources directly involved in the generation of market performance and the subsequent evaluation [40]. Despite the received popularity, this approach is criticized as well. One key aspect of criticism is the lack of concrete guidance on how to identify and classify resources. Therefore, the practical applicability is often questioned.

Building on the concept of PRAHALAD AND HAMEL, the approach of TAMPOE states that core competencies can be primarily found within a technical system [42]. In order to identify core competencies, TAMPOE suggests the analysis of successful products and the extraction of their specific technologies. Thereby, TAMPOE'S approach focuses on technical systems which are relevant for a number of industries. However, it can be criticized, that a pure focus on technical systems might not include all industries, especially not those in which the role of technologies plays only a subsidiary role. Additionally, TAMPOE'S approach has been criticized because it focuses only on already successful established products, neglecting innovations. Since core competencies have a much longer life cycle than products, a focus on successful products neglects hidden core competencies rooted in the company's history. [42]

STEINLE ET AL. follow a rather qualitative approach [43]. Thereby, the authors suggest the performance of semi-standardized interviews with cross-functional key persons to gain information about the availability of competencies for the subsequent development of competency networks. In the process, selected questions are asked about past successes and future opportunities. On a positive note, a past-, present- and future-oriented perspective is taken, thus, providing a comprehensive view of core competencies. On a negative note, the approach is criticized for including only subjective opinions. Furthermore, a neglect of the external perspective (e.g., customers, suppliers, etc.) must be noted since only internal opinions are included in the process.

4.2 Approaches for the Systematic Transfer of Competencies

It can be found that theoretical approaches for the identification of transferable resources are discussed rather superficially in literature. However, the authors aim to present and discuss two relevant approaches.

The authors PODMETINA ET AL. focus on the identification of competencies for the successful implementation of open innovation projects [44]. Thereby, the authors develop the so-called "Competency Model" which describes an arrangement of relevant individual professional competencies for collaboration. The model has strengths in the development and detailed derivation of collaboration competencies. However, due to the pure focus on intangible competencies, it neglects tangible resources like funding, machines, equipment, etc. and thus does not provide a holistic picture of collaboration [44].

The authors RUSANEN ET AL. explore how companies access resources through network relationships when developing service innovations [45]. Thereby, the authors identify the types of resource that companies seek from other actors and examine resource access strategies that can be applied to access each type of resource. The authors state that the transferability of resources is highly dependent on the type of resources. In this connection, physical resources, and general information (e.g., machines, equipment, industry information, etc.) possess a higher level of transferability compared to tacit knowledge and organizational routines (e.g., know-how, reputation, trusted relationships to third parties, etc.). Its strengths lie in its holistic view of tangible and intangible resources, which covers a broader framework of collaboration. However, weaknesses result from the rather superficial description of exchangeable resources. Therefore, the description of transferable resources remains at a high strategic level and does not address specific resources.

4.3 Interim Summary

In total, three superordinate deficits can be identified regarding the transfer of competencies and resources in collaboration between corporates and deep tech startups. First, the current state of research lacks a systematic approach that captures a set of transferable tangible resources and competencies which are required in collaboration between corporates and startups. Second, literature exists in terms of corporate and startup collaboration, even though to date there is no approach that includes the specific characteristics of deep tech startups. Third, there are approaches for identification of competencies and resources in collaboration, while no approach determines the actual supply and demand for resources and competencies in collaboration. Combined with the problems in practice, the identified shortcomings in theory serve as inputs for the derivation of model requirements. These mark the beginning of a targeted model development.

5. Results

The results of this paper describe the conception of the model for the characterization of competencies and resources in collaboration, marking step E in the research process of applied sciences (see section 2).

5.1 Derivation of Requirements

A model for the identification of resources and competencies shall address the deficits presented in the last section. For this purpose, relevant textual and formal requirements are derived and serve as a framework for the development of a model.

Formal requirements serve as a guideline for the development of models and are based on model-theoretical principles. The aim is to ensure the effectiveness and applicability of the model. In his work, PATZAK defines the empirical and formal correctness, the fit for the intended purpose, the manageability as well as the quality of the results as main characteristics. In the present work, these characteristics are adopted as formal requirements [46].

While formal requirements are based on model-theoretical principles, **textual requirements** serve to close the presented shortcomings in literature and specify the target area of the model to be developed. Due to the intention of developing deep tech products or innovating with deep technologies [47], the first textual requirement considers that the **resources and competencies** to be exchanged **enable the** development of such products or innovations. Since corporates seek collaboration to gain access to complementary deep tech products and technologies [22,48], it is of major importance to consider resources and competencies with the potential to support this intention. This is equally important for deep tech startups, which are exposed to a general scarcity of resources, and seek collaboration to get access to competencies which help realizing a market-ready scaling of products and production [3,8,49]. To date, the specific characteristics of deep tech startups are not integrated in the discussion of competencies and resources. However, the authors note that the characteristics of deep tech startups arouse the interest of corporates on the one hand and explain the need for competencies and resources on the other. Therefore, the second textual requirement must ensure that the **characteristics of deep tech startups** (see section 3.1.2) are considered within the scope of this model. This includes the liability of newness and smallness [22], as well as scarcity of resources [23], and the characteristics of a deep technology regarding the technological risk [25], the market risk [17] and the accompanied extensive resource requirements [8]. The third textual requirement derived from the previous sections addresses the **diversity of needs** in terms **of competencies and resources**. As outlined, the access to deep technologies is linked to the provision and the usability of a complex set of competencies and resources (see section 3.1.2). Whereas deep tech startups have multiple needs for specialized resources, corporates often lack competencies and knowledge to drive deep technology developments on their own [22]. To handle this diversity, it is necessary to help both collaboration partners to overcome their inexperience in identifying transferable resources and competencies in the context of a deep tech collaboration. Building on the diversity of needs in the context of deep tech innovations, the fourth textual requirement describes the demand of an **appropriate characterization** of competencies and resources. As deep tech startups have major challenges in reducing the technological risk [17,25] and proving the marketability of their deep technology [50], the needs for competencies and resources differ along the different development stages [51] and are highly dependent on the collaboration partner's offer. Corporates can only bring in suitable competencies and resources if they are aware of the required set [8]. Simultaneously, their demand depends on the competitive advantage gainable through collaboration [39].

5.2 Elaboration of the Model Structure

Collaboration can be characterised by its high degree of complexity and heterogeneity [52]. Therefore, a model for the characterization of transferable competencies needs to have a generic and comprehensive character to capture the various organizational implementations of collaboration [53]. Following the research objective, the derivation and discussion of a model for the identification of transferable competencies and resources consist of two major aspects. On the one hand, an appropriate theoretical approach needs to be identified to categorize and record relevant sets of competencies and resources. On the other hand, specific categories are to be developed to cope with the derived requirements of corporates and deep tech startups.

5.2.1 Scientific approach for the categorization of competencies and resources

After carefully revising, the authors consider a morphology as the best suited approach for the underlying research objective, as it is applied to problems whose number and type of possible solutions are hardly foreseeable and the theoretically existing optimal solution cannot be determined a priori [53]. According to WELTER, the morphology allows a systematic classification of underlying study objects by introducing logical and adapted objectives [54]. Further, ZWICKY describes the morphology as an approach to determine all connections between objects, phenomena, and concepts, while avoiding interference or pre-evaluation [55]. Since the strength of a morphology lies primarily in the systematization and characterization of objects of observation, it is particularly well suited to identifying the relevant competencies and resources raised in the research question of this paper. The morphological box represents one of the most important research methods in morphology [55] and pursues the aim of a holistic ascertainment of the related objectives. The development of a morphological box consists of five consecutive steps [55], of which the paper at hand covers the first three: Step one addresses the exact formulation of the problem [55]. Step two includes the characterization of all characteristic parameters which influence the solution space, whereas step three describes the development of the morphological box including possible solutions, characteristic dimensions, to the given research objective [55]. Induced by the diversity of competencies and resources, as well as by the derived requirements in the context of collaboration between deep tech startups and corporates, the presented morphology is intended to serve as starting point for further research.

5.2.2 Derivation of a superordinate structure for the development of a morphological box

According to ZWICKY [55], the development of a morphology using the method of a morphological box requires the characterization of the study object. A superordinate structure for the morphology is first developed, to enable the identification of competencies and resources in collaborations between corporates and deep tech startups.

A suitable way to address the second step of the morphological box and to identify a characterization of possible competencies and resources in the context of the research question is to look at the life cycle of a company. According to KANZANJIAN, the evolution of companies proceeds along several cross-stage development fields [51]. Whereas corporates are in a phase of continuity and strive for sustained competitiveness, deep tech startups focus on rapid growth and the development and establishment of market perception [6,17]. During the existence of a company, however, the needs change noticeably due to a changing environment [56]. To capture the demand of different competencies and resources over time, relevant development fields are derived from the deep tech startup focus. According to TECH, deep tech startups focus on the development categories **product, market** and **organization** [57]. The high technology risk of implementation in the context of a deep tech startup, indicates that the field of **technology development** is of major focus to enable successful startup product and market establishment [58]. Focusing on deep tech innovations, O'CONNOR AND RICE as well as DENOO include the aspect of additionally performing **business model development** activities in order to create new markets [17,59]. Since neither a product, nor an established value creation or revenue mechanism exists on new markets, it is found to be crucial for deep tech startups to develop a business model.

Focusing on these development areas of deep tech startups and combining them with the aim of successfully identifying and transferring competencies and resources in collaboration, the following five characteristic groups serve to categorize the competencies and resources: **Product development** comprises competencies and resources to enhance the development of a deep tech product [60]. The category **technology development** summarizes competencies and resources with the aim to develop and improve emerging deep technologies [47]. **Market development** describes a category including competencies and resources to actively shape a market environment and to influence market developments [61,62]. The fourth category summarizes all competencies and resources enhancing organizational development in terms of **renewal of structures and processes** [63] or development of competencies to master growth induced **change processes** [64]. Business model development presents the fifth category as it comprises all necessary competencies and resources necessary to **create, convey and capture value from deep technology** [17,62,65]. The categories of competencies and resources resulting from the development fields of a deep tech startup enable the fulfillment of textual requirements. Furthermore, corporates and deep tech startups can obtain a competitive advantage through a transfer of competencies in collaborations considering the new institution economics (see section 3.2). With the five characteristic groups introduced, the basis is created that startups can reduce the technical as well as the market risk of deep technology, while corporates gain access in relevant development areas of deep technology.

5.3 Discussion of the Developed Morphology Characteristics

The applied morphological approach provides in the third step the composition of the morphological box or multidimensional matrix with all possible solutions for the given problem [55]. Due to the complex, yet diverse field of investigation and the early stage of research in this paper, the construction of a morphological box with all possible solutions appears not feasible. The characteristic dimensions derived in the characteristic groups emerge from an extensive literature review and a consortium project on start-up collaboration with six industrial companies. At this stage, the following discussion represents a pre-validation in the context of this given project. As section 2 explains, verification in industrial practice is not covered in this paper but will be carried out in the future.

Product Development

The successful establishment of a deep tech product requires competencies and resources in the introduced category of product development. Within this field, two major aspects of a product are covered – the development and the production. Fig. 3 illustrates potential characteristic dimensions for competencies and resources in the field of product development.

Characteristic Group	Product Development						
Characteristic Dimensions	*Value Chain Position Competencies*	*Product Development Competencies*	*Production Scaling Competencies*	*Production Type*	*Procurement Focus*	*Production Resources Utilization*	*Production Network*

Figure 3: Product Development Characteristics

Value chain position competencies refer to a company's understanding of its own role and position in the overall value chain and its ability to create meaningful value to a product [66]. In the context of a collaboration, this dimension indicates whether a company is e.g., rather an OEM or a raw material supplier. Despite an understanding of its own role along the entire value chain, **product development competencies** relate to the availability of resources and know-how of a company for the development of new products [67,68]. Here, relevance for this dimension emerges from the importance of a transfer of expertise but also tangible resources between corporates and deep tech startups, as both companies cannot cover the entire product development process themselves. After a product idea has been turned into a market-ready product, the product scaling phase requires increasing sales by setting up a suitable production infrastructure. In this context, the characteristic dimension of **production scaling competencies** allows corporates and deep tech startups to identify competencies and resources supporting the scaled production. Production scaling touches on the know-how and skills of a company on how to establish and coordinate an efficient production infrastructure [69–71]. In contrast, the characteristic dimension of the **production type** refers to the potential physical availability of production machinery (tangible resources) which can be shared in collaboration [69,72,73]. Due to a lack of management experience and capital-intensive production resources, deep tech startups typically have a great need for the production competencies of their corporate partners. Besides the availability of production resources, the dimension of the **production resources utilization** also plays an important role for deep tech startups, as it describes the availability of a company's key resources for manufacturing a product [69,72,73]. For the profound elaboration of product development, the procurement of resources should be investigated as well. Therefore, the characteristic dimension of the **procurement focus** covers the experience-based competencies of a company for the strategic establishment and handling of a supplier network [74,75], indicating e.g. synergy benefits or a procurement network. Closely linked to the production resources and the procurement competencies, a morphology for the group product development should eventually consider the **production network** touching on the geographical dispersion of production facilities [76,77] on a local, national or international level.

Technology Development

Major driver of deep tech startups are deep technologies. These technologies need to be developed in order to minimize the technological feasibility risk [17]. In consequence, the involvement of competencies and resources in the field of technology development play an important role in collaboration between corporates and startups. The discussion of characteristic dimensions is summarized in Fig. 4.

Characteristic Group	Technology Development				
Characteristic Dimensions	*Technology Type*	*Technology Development Stages*	*Technological Application Focus*	*Technology Resources Utilization*	*Technology Development Focus*

Figure 4: Technology Development Morphology

The characteristic dimension **technology type** refers to the availability of technological know-how of a company for the development of a specific type of technology, such as product or production technologies [47]. Especially for corporates that want to explore deep technology opportunities outside their core competencies, collaboration can offer access to specialized competencies. Following, the characteristic dimension of **technology development stages** refers to a company's availability of competencies and resources to successfully master all technology readiness levels [78]. Despite know-how, this involves the availability of an established research infrastructure, validation capacities, and excessive funding. The dimension **technological application focus** determines in which application areas of deep tech a company, for example sensing or computation, potentially possess competencies and resources for development [3]. The characteristic of **technological resources utilization** summarizes the availability of key resources of a company to develop a specific deep technology [47,79]. Last, the **technology development focus** refers to a company's strategic position in terms of technology development [47], and indicates the potential support through a corporate.

Market Development

Not only do deep tech startups face a higher technology risk compared to typical startups, but they also face a higher market risk [17]. Therefore, deep tech startups are highly depending on resources and competencies of established corporates in collaboration, especially in terms of market development (Fig. 5).

Characteristic Group	Market Development					
Characteristic Dimensions	*Market Type*	*Stakeholder Management Competencies*	*Customer Type*	*Marketing and Sales Competencies*	*Distribution Type*	*Distribution Network*

Figure 5: Market Development Morphology

The dimension **market type** describes a company's competencies to sell a specific type of product in a market [79]. Thereby, product markets can be distinguished in e.g., durable, or non-durable consumer goods, as companies which seek to enter new markets and industries aim to benefit from the competencies of companies already present in product markets. Since deep tech startups aim to establish products in not yet existing markets, they are dealing with a variety of stakeholders. Thus, **stakeholder management competencies** are summarized, referring to a company's access to key stakeholders and, beyond that, the ability to manage and build strong relationships [80]. Additionally, the dimension of **customer type** extends the market on to competencies around the customer [79,81], for example business-to-business or busines-to-consumer. These include customer understanding, customer approach and customer acquisition. A further characteristic dimension of competencies and resources are **marketing and sales competencies**, referring to a company's know-how of effectively promoting and selling a product as well as access to an established customer network [82]. Due to their liability of smallness, deep tech startups are particularly interested in gaining access to marketing and sales competencies to enable company growth. Developing a market, one also needs to consider the dimension **type of distribution,** e.g., direct sale or e-commerce. Here, the focus is on access to a distribution infrastructure, which can be digital or physical [79]. In this context, the **distribution network** as dimension focuses on a company's competencies to build a local, national, or globalized distribution infrastructure [79].

Organizational Development

As both collaboration partners face major organizational challenges in their respective life cycle phases [80], the field of organizational shall comprise all competencies and resources for future organizational development [81]. Collaborations enable the transfer of characteristic dimensions in organizational development, which are summarized in Fig. 6.

Characteristic Group	**Organizational Development**				
Characteristic Dimensions	*Organizational Structure*	*Focus of Employee Skill Set*	*Reputational Resources*	*Funding Competencies*	*Financial Resources*

Figure 6: Organizational Development Morphology

Thereby, one key characteristic dimension is the **organizational structure** summarizing the ability of an organization to set up an organizational structure and a process landscape which fit their strategy (e.g., exploitation against exploration, functional structure vs. matrix structure) [82]. As part of organizational development, the characteristic **focus of employee skill sets** touches on the competencies of a company's employees, e.g. in terms production, R&D, and which can represent a competitive advantage [80]. In collaboration between corporates and deep tech startups, both companies aim to transfer specialized know-how of their partner to gain a competitive advantage. The dimension of **reputational resources** deals with the external perception of an organisation towards its many stakeholders such as customers, suppliers, or investors [83]. The improvement of its own reputation, for example in terms of product quality or financial resources, represents one central aspect of collaborations between corporates and deep tech startups and is summarized in this characteristic. The characteristic dimension of **funding competencies** refers to a company's know-how in terms of organizational financing [84]. When discussing transferable competencies and resources in the context of collaboration with a deep tech startup, funding competencies such as equity, debt, or venture capital play an important role, since they affect all development fields of a deep tech startup. Similarly, **financial resources** are a key resource of corporates as this dimension describes the monetary availability of capital resources and the willingness of corporates to invest money in deep tech startups [84].

Business Model Development

The purpose of any company is to establish a viable business model to enable growth and continuing existence [85]. As introduced, both collaboration partners are interested in competencies and resources enhancing business model development. Within this characteristic group, the major characteristic dimensions are presented in Fig. 7 and discussed in the following sub-section.

Characteristic Group	**Business Model Development**		
Characteristic Dimensions	*Value Creation Competencies*	*Entrepreneurial Key Competencies*	*Revenue Generation Competencies*

Figure 7: Business Model Development Morphology

As they describe the core of a business model, **value creation competencies** refer to a company's ability to understand what kind of value it creates for its customers and how it can differentiate itself from the competition [86]. In collaboration, deep tech startups can benefit from the corporates expertise in creating value for customers for example in terms of cost leadership, product quality or user experience and establishing value creation competencies, while at the same time corporates can access new ways of creating value. The dimension of **entrepreneurial key competencies** comprises the abilities of company to scale business models efficiently [87]. Here, a focus could for example lie in ideas-to-market, market-to-customer, or customer-to cash. As another fundamental part of business model development, companies must find a way to monetize their product. Therefore, **revenue generation competencies** touch on a company's experience in generating revenues by setting up innovative revenue models [88]. Competencies and resources within this characteristic dimension support the successful implementation of a revenue model for deep tech innovations, such as markup models or subscription models.

After presenting, it can be concluded that the presented characteristic groups follow the morphological approach by ZWICKY [55] and depict a suitable description and categorization of transferable competencies and resources in collaboration between corporates and deep tech startups. The characteristic dimensions are based on the life cycles of companies and consider the derived requirements in the context of deep tech startups. However, the characteristic dimensions introduced represent only the initial development of a morphological box for identifying transferable competencies and resources. As a verification in practice could not be performed to date, completeness of the characteristic dimensions cannot yet be guaranteed.

6. Conclusion and Future Research

The aim of this paper was the development of a model for the systematic characterization of transferable competencies and resources in collaborations between corporates and deep tech startups. Following ZWICKY, the morphological approach was identified as suitable approach for the model development [55]. Thereby, a total of five characteristic groups could be identified as categories for the identification of competencies and resources: Product development, technology development, market development, organizational development, and business model development. For a systematic representation, the development of a morphology using these five groups was outlined. Within the characteristic development groups, the subordinate dimensions of competencies and resources were presented and discussed. It was shown that the systematic identification and characterization of competencies and resources can enable both partners to define transferable competencies and resources of interest in a specific context. The findings of this work outline that deep tech startups require access to the valuable knowledge and resources of corporates to fulfil their growth ambitions. At the same time, corporates seek access to deep technologies to ensure their ability to innovate and, thus, launch new products and business models in untapped markets.

With the morphology developed and discussed within this work, a foundation for further investigation of competency and resource transfer in collaboration between corporates and deep tech startups has been created. Based on the results discussed here, steps four and five (see section 5.2.1) need to be carried out in future research to develop a morphology according to ZWICKY. Through the guided discussion of dimensions from the literature, practitioners are provided with guidance that allows for the encapsulation of inefficiencies and time. The applicability of the particularly relevant competencies and resources is to be achieved through prioritization within the morphology. Accordingly, all characteristic dimensions need to be analysed and evaluated against the background of the purpose of application. As introduced, the best solutions need to be selected and validated in a practical application. The morphological model developed in this way can further be integrated into a procedure for designing collaborations between corporates and start-ups. This procedure is subject of an ongoing dissertation project and will be continuously detailed within the research work.

References

[1] Steiber, A., Alänge, S., 2021. Corporate-startup collaboration: effects on large firms' business transformation. EJIM 24 (2), 235–257.

[2] Moroni, I., Arruda, A., Araujo, K., 2015. The Design and Technological Innovation: How to Understand the Growth of Startups Companies in Competitive Business Environment. Procedia Manufacturing 3, 2199–2204.

[3] Siegel, J., Krishnan, S., 2020. Cultivating Invisible Impact with Deep Technology and Creative Destruction. jim 8 (3), 6–19.

[4] Lau, F., 2019. Modell zur typenbasierten Gestaltung von firmeninternen Inkubatoren, 1. Auflage ed. Apprimus Wissenschaftsverlag, Aachen, 316 pp.

[5] Weiblen, T., Chesbrough, H.W., 2015. Engaging with Startups to Enhance Corporate Innovation. California Management Review 57 (2), 66–90.

[6] Picken, J.C., 2017. From startup to scalable enterprise: Laying the foundation. Business Horizons 60 (5), 587–595.

[7] Chesbrough, H.W., 2003. The Era of Open Innovation. MIT Sloan Management Review Vol. 44 (No.3), 35–41.

[8] La Tour, A. de, Soussan, P., Harlé, Nicolas, Chevalier, Rodolphe, Duportet, X., 2017. From Tech to Deep Tech, 1–52.

[9] Friedli, T., Schuh, G., 2003. Die operative Allianz, in: Zentes, J., Swoboda, B., Morschett, D. (Eds.), Kooperationen, Allianzen und Netzwerke. Gabler Verlag, Wiesbaden, pp. 487–514.

[10] Bannerjee, S., Bielli, S., Haley, C., 2016. Scaling together: Overcoming barriers in corporate-startup collaboration.

[11] Kohler, T., 2016. Corporate accelerators: Building bridges between corporations and startups. Business Horizons 59 (3), 347–357.

[12] Ulrich, H., 1981. Die Betriebswirtschaftslehre als anwendungsorientierte Sozialwissenschaft, in: , Die Führung des Betriebes : Curt Sandig zu seinem 80. Geburtstag gewidmet. Poeschel, Stuttgart, pp. 1–25.

[13] Ulrich, H., 1984. Die Betriebswirtschaftslehre als anwendungsorientierte Sozialwissenschaft, in: Ulrich, H., Dyllick, T., Probst, G.J.B. (Eds.), Management, vol. 13. P. Haupt, Bern etc., pp. 168–199.

[14] Mercandetti, F., Larbig, C., Tuozzo, V., Steiner, T., 2017. Innovation by Collaboration between Startups and SMEs in Switzerland. TIM Review 7 (12), 23–31.

[15] Hilse, H., Susemihl, I., 2018. Erfolgreiche Kooperationen von Corporates und Start-ups: Wie David und Goliath gemeinsam die Geschäfte von morgen entwickeln. Organisationsentwicklung.

[16] Sommer, S.C., Loch, C.H., Dong, J., 2009. Managing Complexity and Unforeseeable Uncertainty in Startup Companies: An Empirical Study. Organization Science 20 (1), 118–133.

[17] Denoo, L., van Boxstael, A., Belz, A., 2020. Help, I Need Somebody! Business and Technology Advice in Emerging Science-Based Ventures. SSRN Journal 56 (1), 76.

[18] Siota, J., Prats, J., 2021. Open Innovation: How Corporate Giants Can Better Collaborate with Deep-Tech Start-ups. The Case of East and Southeast Asia, 1–53.

[19] Conti, A., Thursby, M., Rothaermel, F.T., 2013. Show Me the Right Stuff: Signals for High-Tech Startups. Journal of Economics & Management Strategy 22 (2), 341–364.

[20] Giardino, C., Unterkalmsteiner, M., Paternoster, N., Gorschek, T., Abrahamsson, P., 2014. What Do We Know about Software Development in Startups? IEEE Softw. 31 (5), 28–32.

[21] Ries, E., 2011. The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses, 1st ed. ed. Crown Business, New York, 1 online resource (320).

[22] Hora, W., Gast, J., Kailer, N., Rey-Marti, A., Mas-Tur, A., 2018. David and Goliath: causes and effects of coopetition between start-ups and corporates. Rev Manag Sci 12 (2), 411–439.

[23] Achleitner, A.-K., Braun, R., 2014. Entrepreneurial Finance, in: Faltin, G. (Ed.), Handbuch Entrepreneurship, vol. 57. Springer Fachmedien Wiesbaden, Wiesbaden, pp. 1–20.

[24] Reynolds, E.B., Samel, H., 2013. Manufacturing Startups. Mechanical Engineering 135 (11), 36–41.

[25] Belz, A., 2020. Terms of Endearment: Financing Terms for Deep Technology Startups on a Crowdfunding Platform. SSRN Journal 28 (8), 955.

[26] Rupprecht-Däullary, M., 1994. Zwischenbetriebliche Kooperation. Deutscher Universitätsverlag, Wiesbaden.

[27] Picot, A., 1994. Institutional economics of public firms and administrations: Some guidelines for efficiency-oriented design. Journal of institutional and theoretical economics 11.

[28] Hess, T., 2019. Arnold Picot und die Wirtschaftsinformatik. Schmalenbachs Z betriebswirtsch Forsch 71 (2), 127–136.

[29] Hagenhoff, S. Innovationsmanagement für Kooperationen. Dissertation.

[30] Ketokivi, M., Mahoney, J.T., 2016. Transaction Cost Economics As a Constructive Stakeholder Theory. AMLE 15 (1), 123–138.

[31] Barney, J., 1991. Firm Resources and Sustained Competitive Advantage. Journal of Management 17 (1), 99–120.

[32] Daft, R.L., 1983. Learning the Craft of Organizational Research. The Academy of Management Review 8 (4), 539.

[33] Wernerfelt, B., 1984. A resource-based view of the firm. Strat. Mgmt. J. 5 (2), 171–180.

[34] Duschek, S., Sydow, J., 2002. Ressourcenorientierte Ansätze des strategischen Managements. WIST 31 (8), 426–431.

[35] Gulati, R., 1998. Alliances and networks. Strat. Mgmt. J. 19 (4), 293–317.

[36] Dyer, J.H., Singh, H., Hesterly, W.S., 2018. The relational view revisited: A dynamic perspective on value creation and value capture. Strat. Mgmt. J. 39 (12), 3140–3162.

[37] Hitt, M.A., Ireland, R.D., Hoskisson, R.E., 2020. Strategic management: Competitiveness & globalization : concepts and cases, 13e ed. Cengage, Boston, MA, USA, 30 pp.

[38] Mills, J., Platts, K., Bourne, M., 2003. Competence and resource architectures. Int Jrnl of Op & Prod Mnagemnt 23 (9), 977–994.

[39] Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strat. Mgmt. J. 18 (7), 509–533.

[40] Prahalad, C., Hamel, G., 1990. The core competence of the corporation. Harvard Business School Press, Boston.

[41] GRANT, R., 1999. The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation, in: , Knowledge and Strategy. Elsevier, pp. 3–23.

[42] Tampoe, M., 1994. Exploiting the core competences of your organization. Long Range Planning 27 (4), 66–77.

[43] Steinle, C., Bruch, H., Nasner, N., 1997. Kernkompetenzen: Konzepte, Ermittlung und Einsatz zur Strategieevaluation. Zeitschrift für Planung.

[44] Podmetina, D., Soderquist, K.E., Petraite, M., Teplov, R., 2018. Developing a competency model for open innovation. MD 56 (6), 1306–1335.

[45] Rusanen, H., Halinen, A., Jaakkola, E., 2014. Accessing resources for service innovation – the critical role of network relationships. Journal of Service Management 25 (1), 2–29.

[46] Patzak, G., 1982. Systemtechnik - Planung komplexer innovativer Systeme: Grundlagen, Methoden, Techniken. Springer Berlin Heidelberg, Berlin, Heidelberg.

[47] Schuh, G., 2011. Technologiemanagement: Handbuch Produktion und Management 2. Springer Berlin Heidelberg, Berlin, Heidelberg.

[48] Becker, W., 2018. Kooperationen Zwischen Mittelstand und Start-Up-Unternehmen. Gabler, Wiesbaden, 287 pp.

[49] Hahn, C. (Ed.), 2018. Finanzierung von Start-up-Unternehmen: Praxisbuch für erfolgreiche Gründer: Finanzierung, Besteuerung, Investor Relations, 2., vollständig akutalisierte und überarbeitete Auflage ed. Springer Gabler, Wiesbaden, 309 pp.

[50] Kriz, A., Welch, C., 2018. Innovation and internationalisation processes of firms with new-to-the-world technologies. J Int Bus Stud 49 (4), 496–522.

[51] Kazanjian, R.K., Drazin, R., 1990. A stage-contingent model of design and growth for technology based new ventures. Journal of Business Venturing 5 (3), 137–150.

[52] Axelrod, R.M., 1997. The complexity of cooperation: Agent-based models of competition and collaboration. Princeton University Press, Princeton, N.J, 232 pp.

[53] Baum, H., 2011. Morphologie der Kooperation als Grundlage für das Konzept der Zwei-Ebenen-Kooperation. Gabler, Wiesbaden.

[54] Welter, M., 2006. Die Forschungsmethode der Typisierung: Charakteristika, Einsatzbereiche und praktische Anwendung. Wirtschaftswissenschaftliches Studium.

[55] Zwicky, F. The Morphological Approach to Discovery, Invention, Research and Construction, in: , New Methods of Thought and Procedure. Springer.

[56] Hanks, S.H., 1990. The Organization Life Cycle: Integrating Content and Process. Journal of Small Business Strategy 1 (1), 1–12.

[57] Tech, R.P.G., 2018. Financing High-Tech Startups. Springer International Publishing, Cham.

[58] Schultz, C., 2011. Die Finanzierung technologieorientierter Unternehmen in Deutschland. Gabler, Wiesbaden.

[59] O'Connor, G.C., Rice, M.P., 2013. New Market Creation for Breakthrough Innovations: Enabling and Constraining Mechanisms. J Prod Innov Manag 30 (2), 209–227.

[60] Knop, R., 2009. Erfolgsfaktoren strategischer Netzwerke kleiner und mittlerer Unternehmen. Gabler, Wiesbaden.

[61] Porter, M.E., 1998. Competitive Advantage: Creating and Sustaining Superior Performance, 2. Auflage ed. Free Press, Riverside, 489 pp.

[62] Göcke, L., 2016. Geschäftsmodellentwicklung im Spannungsfeld multinationaler Unternehmen. Springer Fachmedien Wiesbaden, Wiesbaden.

[63] Schiersmann, C., Thiel, H.-U., 2018. Organisationsentwicklung. Springer Fachmedien Wiesbaden, Wiesbaden.

[64] Schweiger, C., 2012. Junge Technologieunternehmen. Gabler Verlag, Wiesbaden.

[65] Schallmo, D.R.A., 2018. Geschäftsmodelle erfolgreich entwickeln und implementieren. Springer Berlin Heidelberg, Berlin, Heidelberg.

[66] Kenessey, Z., 1987. The Primary, Secondary, Tertiary and Quaterny Sectors of the Economy. Rev Income Wealth 33 (4), 359–385.

[67] Feldhusen, J., Grote, K.-H., 2013. Pahl/Beitz Konstruktionslehre. Springer Berlin Heidelberg, Berlin, Heidelberg.

[68] Schuh, G., 2012. Innovationsmanagement. Springer Berlin Heidelberg, Berlin, Heidelberg.

[69] Eversheim, W., 1989. Organisation in der Produktionstechnik Band 4: Fertigung und Montage, 2nd ed. Springer, Berlin, Heidelberg.

[70] Bellmann, K., Himpel, F., Böhm, A., 2010. Messung von Flexibilität in der Produktion, in: Strohhecker, J., Größler, A. (Eds.), Strategisches und operatives Produktionsmanagement, vol. 78. Gabler, Wiesbaden, pp. 221–240.

[71] Zeichen, G., Favre-Bulle, B., Zoitl, A., Prenninger, J., 2008. Kriterien für die Exzellenz der Produktion. Zeitschrift für wirtschaftlichen Fabrikbetrieb 103 (5), 328–332.

[72] Kern, W. (Ed.), 1979. Handwörterbuch der Produktionswirtschaft: HWProd. Poeschel, Stuttgart, 2446 pp.

[73] Kistner, K.-P., Steven, M., 2001. Produktionsplanung, Dritte, vollständig überarbeitete Auflage ed. Physica-Verlag HD, Heidelberg, s.l., 372 pp.

[74] Schuh, G., Hoppe, M., Schubert, J., Mangoldt, J. von, 2014. Lieferantenauswahl, in: Schuh, G. (Ed.), Einkaufsmanagement, vol. 2. Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 183–253.

[75] Hofbauer, G., Glazunova, A., Hecht, D., 2015. Strategische Lieferantenauswahl. Der Präsident der Technischen Hochschule Ingolstadt, Ingolstadt, 51 pp.

[76] Bidlingmaier, J., 1967. Absatzpolitik und Distribution: Karl Christian Behrens Zum 60. Geburtstag. Springer Gabler. in Springer Fachmedien Wiesbaden GmbH, Wiesbaden, 440 pp.

[77] Schneider, D.J.G., 1973. Unternehmungsziele und Unternehmungskooperation: Ein Beitrag zur Erklärung kooperativ bedingter Zielvariationen. Gabler Verlag, Wiesbaden, 183 pp.

[78] Mankins, J.C., 2009. Technology readiness assessments: A retrospective. Acta Astronautica 65 (9-10), 1216–1223.

[79] Mangoldt, J. von, 2018. Methode zur Ausrichtung der technologiekompetenzbasierten Diversifikation. Dissertation, 1. Auflage ed.

[80] Mintzberg, H., 1979. The structuring of organizations: A synthesis of the research. Prentice-Hall, Englewood Cliffs, N.J., 512 pp.

[81] Grimpe, C., Murmann, M., Sofka, W., 2019. Organizational design choices of high-tech startups: How middle management drives innovation performance. Strategic Entrepreneurship Journal 13 (3), 359–378.

[82] Schreyögg, G., 2016. Grundlagen der Organisation. Springer Fachmedien Wiesbaden, Wiesbaden.

[83] Helm, S., Liehr-Gobbers, K., Storck, C., 2011. Reputation Management. Springer Berlin Heidelberg, Berlin, Heidelberg.

[84] Becker, H.P., 2008. Investition und Finanzierung. Gabler, Wiesbaden.

[85] Trimi, S., Berbegal-Mirabent, J., 2012. Business model innovation in entrepreneurship. Int Entrep Manag J 8 (4), 449–465.

[86] Porter, M.E., 1998. Competitive strategy: Techniques for analyzing industries and competitors : with a new introduction. Free Press, New York, 396 pp.

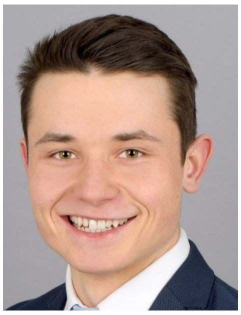
[87] DaSilva, C.M., Trkman, P., 2014. Business Model: What It Is and What It Is Not. Long Range Planning 47 (6), 379–389.

[88] Lukas, T., 2018. Business Model Canvas – Geschäftsmodellentwicklung im digitalen Zeitalter, in: Grote, S., Goyk, R. (Eds.), Führungsinstrumente aus dem Silicon Valley, vol. 69. Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 143–159.

Biography

Prof. Dr.-Ing. Dipl.-Wirt. Ing. Günther Schuh (*1958) holds the chair for Production Engineering at RWTH Aachen University. Furthermore, he is director of the FIR e. V., member of the board of directors of the WZL of the RWTH Aachen University and the Fraunhofer Institute for Production Technology (IPT).

Bastian Studerus (*1991) holds a M.Sc. degree in Business Administration and Mechanical Engineering from the RWTH Aachen University and Linköpings Universitet. Since 2018, he is a research fellow (Dr.-Ing.) in the department Strategic Technology Management at the Fraunhofer Institute for Production Technology (IPT).



Aaron Rohmann (*1998) holds a double degree in International Management (B.Sc.) and International Business (B.BA.) from the ESB Business School, Reutlingen and Avans Hogeschool, Breda. Since 2021, he is a student research fellow in the department Strategic Technology Management at the Fraunhofer Institute for Production Technology (IPT).