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Digital Innovation Units in Industrial-Age Contexts - Paradoxes, Ambidexterity and Symbiotic Collaboration

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DIGITAL INNOVATION UNITS IN INDUSTRIAL-AGE CONTEXTS – PARADOXES, AMBIDEXTERITY AND SYMBIOTIC COLLABORATION

Research Paper

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Abstract: Aspiring to close capability gaps for digital innovation, industrial-age incumbents often decide to establish Digital Innovation Units (DIUs), which are separated from the main organization both geographically and with regard to their techniques, skills and working styles. This separation is problematic as digital innovation in these contexts is about the combination of digital and physical components. The organizational separation enables a distinct focus yet hinders collaboration. To resolve this paradoxical situation, incumbents need to transcend mere separation. As prior research falls short in explaining how DIUs and main organizations can cooperate symbiotically, we conducted a Delphi survey involving 23 automotive experts to discover some answers. From the specific findings, we abstract three meta-patterns: maintaining structural autonomy, strategic boundary spanning and operational synchronizing. We synthesize these meta-patterns into a multi-layered organizing model and relate our findings to paradox and ambidexterity theory. We derive important implications for IS research and managerial practice.

Keywords: Digital Innovation, Delphi Study, Paradoxes, Ambidexterity, Digital Innovation Units.

1 Introduction

Survival or growth without embracing digital innovation (DI) appears to be unattainable in recent times (Nambisan et al., 2017, Yoo et al., 2012). This holds true not only for actors in IT or service industries but also for incumbent firms in industrial-age industries (Hylving and Schultze, 2020). Thereby, industrial-age industry incumbents confront increasing challenges to engage in DI (e.g. Dremel et al., 2017, Svahn et al., 2017) since they are built on a rich history of incremental, pre-specified innovation within a physical product setting (Hylving et al., 2012). Thus, lacking vital digital capabilities to engage in DI (Yoo et al., 2012, Sambamurthy et al., 2003), incumbents face a significant threat of being superseded by born-digital complementors (Skog et al., 2018, Gregory et al., 2018).

Industrial-age incumbents, to close capability gaps for DI, have engaged in several initiatives (Jöhnk et al., 2022) such as the investment in digital M&A (Hanelt et al., 2021b), the forging of external digital partnerships (Chanias et al., 2019) or the recruitment of digital talents (Ciriello and Richter, 2015). Apart from that, academia, like practice, considers the internal establishment of dedicated digital innovation units (DIU) as a viable DI initiative (e.g. Jöhnk et al., 2022). DIUs can be defined as "autonomous entities that aid their respective main organization (MO) in the development of digital capabilities and in the search for and creation of new digital products, services, and processes" (Schumm et al., 2022). Compared to other measures, DIUs are unique since they are not targeted at the mere sourcing of specific capabilities but represent an organizational alteration aimed to create digital components internally, thus developing idiosyncratic knowledge. Prior research on DIUs has mainly delineated objectives, types and characteristics (e.g. Raabe et al., 2021), while research on the cooperation between DIUs and their MO remains scarce (Schumm et al., 2022). Closing this knowledge gap is crucial to understand how industrial-age incumbents utilize DIUs' inherent digital capabilities to pave the way for DI.

In industrial-age industry contexts, DI, defined as “the carrying out of new combinations of digital and physical components to produce novel products” (Yoo et al., 2010), is based on a layered modular architecture that consists of both physical and digital components (Yoo et al., 2010). Research indicates "that developing this architectural prerequisite of digital innovation is fraught with tensions and conflicts" (Hylving and Schultze, 2020), since physical and digital innovation processes differ significantly in terms of velocity, presumptions, structure, and cultural underpinnings (Hanelt et al., 2021b, Henfridsson et al., 2014). Further, these tensions also emerge at the organizational level (Viljoen et al., 2022, Wimelius et al., 2021, Toutaoui et al., 2022), as the organizational governance of manufacturing physical items is fairly hierarchical and sequential, while digital products impose more networked and loosely coupled organizational structures (Hanelt et al., 2021b). With a concrete focus on DIUs, this could lead to a paradoxical situation; While separating digital capabilities into independent units (DIUs) enables a dedicated DI focus (Schumm et al., 2022), this separation makes it increasingly challenging to interact and collaborate with the MO (Svahn et al., 2017). Hence, in accordance with paradox research, separating digital entities from physical heritage appears logical; however, this separation seems absurd when digital and physical components must be combined to produce multi-layered digital innovations (e.g., Smith and Lewis 2011). The resulting organizational tensions have been characterized as paradoxical in nature (Smith and Lewis 2011) and the underlying foundation is framed as *physical-digital paradoxes* (Piccinini et al., 2015). Prior research has established that paradoxical organizational tensions can be mitigated by ambidexterity (Gregory et al., 2015), "an organization's ability to pursue two disparate things at the same time" (Gibson and Birkinshaw, 2004).

This situation emphasizes the paradox perspective on ambidexterity (Gregory et al., 2015), which promotes synthesis and transcendence over separation, and regards both poles of a paradox cooperatively rather than competitively (Papachroni et al., 2014). While we know that industrial-age incumbents struggle to engage in DI and consider DIUs as one potential DI initiative, we do not know how the critical process of effective and symbiotic cooperation between DIUs and MOs can be achieved (Schumm et al. 2022). Accordingly, this research focuses on the following research question: *Which factors can sustainably contribute to an effective and symbiotic cooperation between DIUs and their main organization?*

To investigate our exploratory research question, we conducted a Delphi study (Paré et al., 2013). Our study is based on the insights of 23 industry experts from DIUs within the automotive industry as this context presents a recent and suitable setting to investigate the challenges of DI in industrial-age contexts (Hylving and Schultze, 2020, Svahn et al., 2017, Hanelt et al., 2021b). Furthermore, research acknowledged that automotive OEMs ought to expedite DI efforts by launching DIUs (e.g. Wulf et al., 2017, Svahn et al., 2017, Dremel et al., 2017). Our Delphi study provides a final list of 13 consolidated and rated key factors. We distilled three meta-patterns – *Maintaining Structural Autonomy, Strategic Boundary Spanning,* and *Operational Synchronizing* and synthesized our empirical findings into a multi-layered organizing model. We relate our results to the paradox perspective on ambidexterity (Papachroni et al., 2014) as we deduce factors that alleviate the tension-filled segregation of DIUs and MOs and extend the previous separation-dominated perspective.

Our study contributes to IS research, particularly in the field of DI in incumbents, by demonstrating how layered product architectures result in organizational adaptations (Hylving and Schultze, 2020, Hanelt et al., 2021a) and how this affects various layers of organizing (Arghavan Shahlaei and Kazan, 2020, Drechsler et al., 2020). Further, we contribute to the emerging literature on DIUs by providing three distinct meta-patterns which can foster collaboration between DIUs and MOs (e.g., Haskamp et al., 2021; Raabe et al., 2020). Lastly, we contribute to the ambidexterity literature by further detailing antecedents to achieve a symbiotic balance between separated entities (Raisch and Birkinshaw, 2008). These insights provide a fruitful blueprint for practitioners to set up DIUs in industrial-age contexts.

2 Theoretical Background

2.1 Digital Innovation in Industrial-Age Contexts

DI in industrial-age contexts is unique. While it seems as if born-digital organizations are proficient at developing DI (Huang et al., 2017), this process is considered especially challenging in industrial-age contexts (Hanelt et al., 2021b) since they draw on "a strong hardware legacy, where development processes and organizational structures are typically adjusted and reflected in the physical product, i.e., the car" (Hylving and Selander, 2012). This leads to a lack of important digital capabilities (Yoo et al., 2012), which incumbents are aided to close, as they face a significant threat of being superseded by born-digital complementors (Skog et al., 2018, Gregory et al., 2018). Establishing DIUs as one vital DI initiative (Jöhnk et al., 2022), enables incumbents to create an internal unit that a) focuses its efforts and resources expressly on the creation of DIs (Raabe et al., 2020) as well as b) incorporates and expands digital capabilities via its agile and post-bureaucratic organizational form (Hellmich et al., 2021).

However, since DI in industrial and physical settings consists of a combination of physical and digital components (Yoo et al., 2010), attempting to resolve DI challenges by establishing a separated internal DI engine uncovers and exacerbates certain tensions (Svahn et al., 2017), meaning a certain notion of "stress, anxiety, discomfort, or tightness in making choices, responding to, and moving forward in organizational situations" (Putnam et al., 2016) resulting from contradicting demands (e.g., Ciriello and Mathiassen, 2022). In detail, it results from the peculiarity that physical components are constructed in a rather static and hierarchical architecture and require a solid pre-specification as well as defined attributes before production (Baldwin et al., 2000), while digital components follow an iterative, evolving, and reprogrammable functional logic and architecture (Yoo, 2010), which remains flexible during the innovation process (Henfridsson et al., 2014). Albeit decoupled, both layers are interconnected (Yoo et al., 2010), leading scholars to assert that this can cause various tensions (Hylving and Schultze, 2020). Further, these tensions embedded in the product architecture can also emerge at the organizational level, as the organizational governance of manufacturing physical items is rather hierarchical and sequential, while digital products impose more networked and loosely coupled organizational structures (Hanelt et al., 2021b), and "a new organizational form that departs dramatically from traditional industrial production" (Berente, 2020). This leads to a number of organizational tensions on several contradicting levels, e.g., roles, boundary openness, knowledge sharing and responsibilities, as two diverse organizational structures and logics must be connected, merged, and coordinated (Hylving and Schultze, 2020, Svahn et al., 2017). Concrete automotive industry examples illustrate tensions caused by: (1) different development cycles, which may differ by years but must be combined: leading to tensions in contradicting planning logics (e.g., weekly SCRUM-sprints vs. multi-year R&D-plans; (2) disparate work cultures, routines, and ideologies that must be aligned with customer requirements: leading to tensions due to contradicting assumptions (e.g., self-organization vs. hierarchy) (Porsche-Consulting, 2020, McKinsey, 2020). Concluding, merging physical and digital components to achieve DI in incumbents raises tensions (Piccinini et al., 2015), as each layer consists of its own set of product and organizational rules and standards that must be combined (Henfridsson et al., 2009). Establishing DIUs can lead to a paradox situation when organizations aim to separate their physical and digital worlds. Although the separation is necessary for digital innovation (Hellmich et al., 2021), it can also increase tensions between the physical and digital realms (Svahn et al., 2017). This paradox situation arises because merging the outcomes of DIUs and MOs requires close collaboration, while the establishment of DIUs emphasizes their distinctiveness.

2.2 Digital Innovation Units

DIUs represent a time topic in IS research, but the scholarly inquiry remains in its infancies (Holotiuk and Beimborn, 2019, Raabe et al., 2021). DIUs are characterized as flexible and creative (Barthel et al., 2020), focused on the context of DI (Raabe et al., 2020), by using agile practices (Haskamp et al., 2021) and employing a close orientation towards the customer (Haskamp et al., 2021). Their purpose includes

the internal generation of digital services or products (Barthel et al., 2020, Fuchs et al., 2019), like automotive clouds and infotainment apps (Svahn et al., 2017). Their activities focus inherently on digital or digitally influenced objectives (e.g. Raabe et al., 2020), which sets them apart from other types of innovation entities (e.g. Gassmann and Becker, 2006). In addition, DIUs are further set apart from traditional R&D departments since they do not limit themselves to established industry standards and boundaries, but strive to go beyond and create new outcomes that exceeds current value creation with a digital focus (e.g., Schumm et al., 2022, Smith and Beretta, 2021). Compared to other DI initiatives, such as the investment in digital M&A (Hanelt et al., 2021b), or the establishment of external digital alliances (Chanias et al., 2019), DIUs' establishment is defined by several distinguishing characteristics (e.g. Barthel et al., 2020, Svahn et al., 2017). They do not only drive the creation, development, and supply of new digital products, services, and processes internally but also represent an organizational alteration and therefore impact MOs' traditional work approaches directly by disseminating post-bureaucratic and agile work techniques such as Design Thinking, Scrum, and Kanban (Fuchs et al., 2019, Ciriello and Richter, 2015). Research describes a vital necessity of internal agility for DIUs in terms of light governance mechanisms and low authority hierarchies to allow high degrees of freedom, autonomy and a focus on creativity (Ciriello and Richter, 2015, Fuchs et al., 2019, Jöhnk et al., 2020). DIUs are able to incorporate this agility since they are structurally and culturally separated from the MOs' bureaucratic environment (Holsten et al., 2021). However, pursuing DI requires a symbiotic and effective collaboration on par with both intertwined layers of physical and digital components (Yoo et al., 2010). Consequently, DIUs' outcomes and capabilities must be merged and combined with those of the MOs (Svahn et al., 2017). While current research on DIUs emphasizes their purpose to facilitate DI and their detachment from the MOs, little is known about the mechanisms and approaches of cooperation and collaboration with and integration into the MOs (Brauer et al., 2021). Although DIUs are a part of the MO, there is a dearth of study on the organizational or procedural foundations necessary for establishing symbiotic and effective cooperation (Schumm et al. 2022). Closing this knowledge gap is crucial for realizing DIUs' benefits (e.g. Svahn et al., 2017). As such, it is necessary to investigate prospects for establishing an organizational foundation for a collaborative DI development and a longitudinal cooperation between DIUs and MOs.

2.3 Paradoxes and Organizational Ambidexterity

Given the complexities of modern societies and economies, paradoxes and their underlying tensions are fundamental elements of organizational life (Papachroni et al., 2014). Paradoxical tensions are understood as the presence of two "elements that seem logical individually but inconsistent and even absurd when juxtaposed" (Smith and Lewis, 2011). Among the many paradoxes of organizational life (Papachroni et al., 2014), separating and compartmentalizing DIUs from the MO to enable a digital focus, while simultaneously depending on a close cooperation to merge the results can be described as inherently burdened with paradoxical tensions. This *physical-digital paradox* (Piccinini et al., 2015) on an organizational level, is rooted in separating the contradicting logics of top-down configured physical components and bottom-up configured digital components, which nevertheless need to be merged (Hanelt et al., 2021b, Hylving and Schultze, 2020). Prior research has established ambidexterity as one approach to mitigate such paradoxical tensions (Gregory et al., 2015) as it is defined as an organizational capability to pursue divergent things simultaneously (Gibson and Birkinshaw, 2004). Besides a rather separation-oriented research stream that deems structural, contextual, or temporal segregation as an applicable approach to achieve ambidexterity (Papachroni et al., 2014), recent studies have embraced a paradox perspective to successfully handle two diametrically opposed organizational poles at the same time (Papachroni et al., 2014, Andriopoulos and Lewis, 2009, Danneels and Viaene, 2022). They consider that resolving paradoxical tensions and ambidexterity are intrinsically related and should be examined in conjunction (Gregory et al., 2015). Consequently, the goal is to establish sustainable solutions that encourage symbiotic synthesis and transcendence (Chen, 2003), as opposed to establishing distinct local optima, which leads to an increasing segregation (Smith and Lewis, 2011). Thus, to address tensions between two contradictory and segregated, yet cohesive, organizational entities, the lens of paradox may aid in accomplishing ambidexterity (Papachroni et al., 2014) while relying on first

approaches to implement suitable integration antecedents for ambidexterity (e.g., structure, context and, leadership) (Raisch and Birkinshaw, 2008). Following prior literature (Gregory et al., 2015), ambidexterity is associated with such a situation and might be pursued by measures of organizational separation such as setting up DIUs. Indeed, initial research associates the establishment of DIUs with ambidexterity (e.g. Fuchs et al., 2019, Göbeler, 2020). Exemplarily, Jöhnk et al. (2020, p.2) claim that DIUs "purposefully […] foster ambidexterity" and facilitate the development of digital components by structurally separating *physical* and *digital* into two distinct poles, which, however seems to exacerbate rather than relieve tensions between the physical and digital worlds (Svahn et al., 2017), as the focus lies on separation- rather than integration-practices. These studies examine the relationship between DIUs and MOs via a predominantly separation-oriented lens on ambidexterity (e.g. Brauer et al., 2021, Holotiuk and Beimborn, 2019). A paradoxical perspective on ambidexterity, however, would allow proceeding beyond separation-oriented prescriptions and towards the synthesis or transcendence (i.e., integration) of two paradoxical poles that may aid organizations in achieving greater success (Papachroni et al., 2014) and "find some new perspective which eliminates the opposition between A and B" (Poole and Van de Ven, 1989). This perspective can lay the groundwork for future symbiotic integration and cooperation between DIUs and MOs, but it is currently missing in the scholarly discourse.

3 Methodology

The application of an exploratory approach such as the Delphi study has a number of benefits in certain research situations and is qualified as suitable for seeking recommendations from specialists when approaching an IS research topic (Skinner et al., 2015). The approach is particularly valuable when, first, the research field is relevant to practice, and predictive theories or contexts need to be explored, while the research question is rather forecasting and can not be answered by case observations (Okoli and Pawlowski, 2004, Singh et al., 2009), second, when "the problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis" (Linstone and Turoff, 1975) and, third, when little or no empirical research is accessible on certain topics or research problems (Paré et al., 2013). Given these circumstances, we chose the Delphi method since there is no previous research on the collaboration between DIUs and their MOs accessible that considers the organizational side of the *digital-physical paradox*, and we are engaged in a comparatively recent and predictive area of inquiry. Considering the scarcity of empirical evidence and the context-specific solution space, we intend to bring together multiple expert perspectives into one conversation (Schmidt et al., 2001, Skinner et al., 2015). We are led in our endeavour by many noteworthy examples from the IS literature that use the Delphi study (e.g. Okoli and Pawlowski, 2004, Paré et al., 2013, Piccinini et al., 2015, Singh et al., 2009). The Delphi study is based on a collaborative discussion among experts and the aggregation of individual contributions on a specific topic related to their area of expertise (Singh et al., 2009, Skinner et al., 2015). The Delphi method enables a structured discussion between experts that takes place via controlled processes providing constant feedback on an anonymous basis (Schmidt et al., 2001, Singh et al., 2009). Four basic conditions of empirical validation must be adhered to conducting the Delphi study: First, the anonymity of individual participants; second, iteration of different phases; third, the provision of controlled feedback; and fourth, a statistical treatment of the results (Singh et al., 2009). The Delphi method benefits from its modest panel size (Okoli and Pawlowski, 2004) since it builds on experts with eminent expertise and experience in the reviewed field (Skinner et al., 2015). It usually falls between 10 and 30 participants (Baldwin-Morgan, 1993, Kasi et al., 2008, Keil et al., 2002). However, smaller sample sizes of 10-18 people can also provide robust findings (Okoli and Pawlowski, 2004) since it is deemed unlikely that another, smaller group with the same level of expertise will provide drastically different outcomes (Skinner et al., 2015). Our study is inspired by Schmidt's (1997) three-step procedure of: (1) brainstorming, (2) selection, and (3) ranking (Schmidt, 1997) and additionally considers further recommendations from more recent studies (e.g. Okoli and Pawlowski, 2004, Paré et al., 2013, Singh et al., 2009).

3.1 Panel Selection

The Delphi method requires significantly suitable participants with appropriate expertise (Okoli and Pawlowski, 2004, Singh et al., 2009, Skinner et al., 2015). Selecting the appropriate sample group is a critical component when generating reliable and worthwhile findings (Singh et al., 2009). To successfully identify suitable experts, we followed the detailed guidelines of Okoli and Pawlowski (2004). In the first step, we carefully defined criteria for suitable experts and consequently narrowed the selection accordingly (Okoli and Pawlowski, 2004). We decided to concentrate on the automotive sector as it exemplifies a typical industrial-age incumbent (Hylving and Selander, 2012, Svahn et al., 2017) and since previous research acknowledged that automotive OEMs aim to enhance their DI efforts by launching DIUs (e.g. Wulf et al., 2017, Svahn et al., 2017, Dremel et al., 2017). Since our study focuses on factors contributing to a sustainable collaboration between DIUs and MOs, we limited the panel to specialists assigned directly to DIUs. As DIUs generally interface with many different partners within the MO (Fuchs et al., 2019), we can ensure - in contrast to MO employees - that our experts share a broad range of experience in terms of collaboration. In addition, we underscored the importance of including experts from DIUs that have been on the market for at least five years and have experienced constant staff growth, which can serve as an indicator of their vital position and integration into the MOs. We identified the suitable DIUs by doing a comprehensive search and contacting all DIUs inside one of the world's leading multinational, multi-brand automotive OEM. After selecting eligible experts from our direct network, we contacted them by mail, via telephone, or in personal contact and asked them to name other potential participants as recommended by Okoli and Pawlowski (2004). We were able to engage 23 participants in 17 distinct DIUs. Significant weight was placed on participants' DIU competence as well as on the units' selection criteria. This is reflected by the high level of professional expertise (e.g., 9 experts with 11-15 years and 10 experts with > 16 years), the widespread sharing of long-term DIU experiences (e.g., 14 experts with 4-6 years and 2 experts with > 7 years), and the exclusive focus on decision-makers, e.g., DIU (sub-)division manager, team-leader or DIU-founder.

3.2 Data Selection

Following Schmidt (1997), our data collection process consisted of three phases: *brainstorming*, *selection*, and *rating*. The first phase additionally included a validation round, and the latter was conducted in two rounds, resulting in a total of 5 interactions. To minimize effort for participants, we refrained from physical discussion rounds and meetings and conducted each round via an online survey tool and e-mail (Singh et al., 2009, Skinner et al., 2015). We validated each survey for comprehensibility and functionality with academics and practitioners who were not part of the survey beforehand to prevent misunderstandings and extra effort (Singh et al., 2009, Skinner et al., 2015). During the first phase, we invited the experts to name factors that sustainably contribute to effective and symbiotic cooperation between DIUs and the MO. We provided an appropriate context definition in advance to narrow the solution space as precisely as possible (Skinner et al., 2015). Following Singh et al. (2009), we instructed the experts to name between 5 and 8 factors. Further, we invited experts to provide additional explanations for their responses voluntarily (Skinner et al., 2015). This can contribute significantly to the comprehensibility of the individual answers and their context (Okoli and Pawlowski, 2004). By the end of the first phase, 23 panellists named 128 factors. To increase the clarity of responses and to avoid redundancies, in the next step, we a) cleared the list of factors from duplicate responses and b) consolidated them in case of similar responses (see for a detailed explanation of the reduction procedure: Schmidt et al., 2001, Singh et al., 2009). The aggregated list consists of 36 individual factors. We classified them into categories that were subsequently and inductively formed. Aggregation, category development, and assignment occurred iteratively between the authors (Schmidt, 1997, Singh et al., 2009). To ensure that we allocated all replies to the relevant categories and that all responses were appropriately represented, we issued a verification request to our panellists (Skinner et al., 2015). This is deemed relevant to reduce the effect of noise, i.e., misunderstanding due to misinterpretation (Paré et al., 2013, Singh et al., 2009). In the second phase, the consolidated list undergoes a selection process in which the experts are asked to choose the ten most relevant factors without considering any action of

ranking (Schmidt, 1997). The experts are supplied with a list of factors in a randomized order to avoid biases (Schmidt, 1997). After the appropriate time and number of reminders, we completed the second phase with 19 responses, a satisfactory response rate of 83%. Based on Singh et al. (2009), we chose a cut-off value of 30% to reduce the list of factors to a manageable range of 12-15 factors (Skinner et al., 2015). In our case, this reduction leads to 13 factors. The final phase required the experts to rank the remaining factors according to their personal significance and relevance. Following Singh et al. (2009), we provided controlled guidance in the form of the previous round's percentage of choice (Schmidt, 1997). To obtain a robust result of a Delphi study, a certain level of consensus between the experts' answers is necessary (Schmidt, 1997). To evaluate the consensus of non-parametric rankings, various metrics are available in the literature, among which Kendall's coefficient of concordance (W) is described by other researcher as the most suitable one for Delphi studies (Okoli and Pawlowski, 2004, Paré et al., 2013) since dissensus and consensus are immediately recognizable, and the decision to proceed is unambiguous (Skinner et al., 2015). Kendall's W can be determined with the following equations (Kendall and Babington Smith, 1939):

$$\text{(Eq. 1):}\quad W = \frac{12 \times S}{m^2(n^3 - n)}$$

Whereby m are the total judges and n are the total objects (factors). S is the sum of squared deviations and defined as:

$$\text{(Eq. 2):}\quad S = \sum_{i=1}^{n}(R_i - \bar{R})^2$$

$\bar{R}$ is the mean value of the total ranks and R_i are the total ranks given to object i.
Kendal's W ranges from 0 to 1, with 0 meaning no consensus and 1 meaning perfect consensus among all respondents (Kendall and Babington Smith, 1939). Different W-values can be narrowed down: Values from 1 to 0.7 are referred to as strong consensus levels, values from 0.7 to 0.5 as moderate consensus levels, and values from 0.5 to 0 as weak consensus levels (Schmidt, 1997).

In our third phase, 17 participants achieved a W-factor of 0.23 in the first round. It is common practice to conduct further rounds in Delphi studies - as long as at least moderate consensus is reached - to increase the level of consensus through guided feedback (Paré et al., 2013, Singh et al., 2009). In this process, participants are asked to refine their ranking based on additional information, including, for example, the ranking obtained in the previous round and the participants' comments (Schmidt, 1997, Skinner et al., 2015). Schmidt (1997), however, argues that the continuation of the study lies in the researchers' hands and can also be stopped by other factors. The so-called stopping rules are: reaching a satisfactory consensus, no significant change in consensus between two successful rounds, or jeopardizing the feasibility of another round by a high drop-off of participants (Schmidt, 1997). In case of overload or excessive time and resource usage due to further ranking rounds, a low consensus can also be considered valid (Paré et al., 2013). Based on the participation of our experts in the previous phases, we decided to conduct another round. In our second round of phase 3, we attained a W-factor of 0.53 among 13 participants. We decided not to conduct another round for two reasons. First, we felt a fatigue of our experts to participate in further rounds, which was shown by the visible drop-off and the number of reminders sent. This meets the criteria for a stop when a) a considerable drop-off occurs and b) continuance is not assured in terms of resources and time (Okoli and Pawlowski, 2004). Second, with our level of consensus, we have achieved a W-factor that has been comparably high across successfully conducted and well-published Delphi studies (e.g., W=0.52 in Kasi et al. (2008)), leading to a resilient research contribution (Skinner et al., 2015).

4 Findings

During the brainstorming phase, a total of 123 factors were uncovered. They were distilled into 36 distinct factors, which were then divided into eight categories. The categories are termed *Organizational Forms and Structures (OFS)*, *Culture (CU)*, *Leadership and Management (LM), Communication (CO), Value Creation (VC), Strategy (S), Processes & IT (PI)* and *Funding (F).* In the second round, the selection phase, our experts were asked to name their ten most important factors from the brainstorming

phase. By applying a 30% cut-off value (Singh et al., 2009), the list was reduced to a manageable size of 13 factors (Skinner et al., 2015). Afterward, in the last phase, the factors were ranked by the experts. Table 1 presents the results of phases two and three. The final phase involved two rounds of ranking. After an unsatisfactory W-factor in the first round, a correspondingly higher result was generated after the second round.

Factor (Category)	**Selection Phase** (of experts)	**Round 1 Mean rank**	**Round 2 Mean rank**	**Final Rank**
Advisory board in the MO & structural linkage to the top management of the MO (OFS)	47%	4,53	2,92	1
DIUs strategy and vision derived from overall strategy of MO to avoid (uncoordinated) co-existence (CU)	68%	3	3,77	2
Top management commitment & support from MO (LM)	74%	3,12	3,92	3
Organizational & structural incentives for collaboration with DIUs (OFS)	42%	4,88	5,08	4
Focus on digital products with high added value and high innovation in the DIUs (S)	37%	4,41	5,23	5
Partnership-based and transparent value creation between DIUs & MOs - from idea to operation (VC)	47%	4,59	5,46	6
Adaptable & flexible organizational structures in DIUs (OFS)	37%	6,18	7,46	7
DIUs act at eye level with MO through mutual understanding and trust (CU)	42%	5,18	7,61	8
Mutual, demand-oriented portfolio development between labs & MO (with end customers) (VC)	47%	4,65	8,15	9
Rotation principle of the employees between DIU & MO (OFS)	32%	6,59	9,38	10
Prevention of personal "power games between DIUs & MO (LM)	32%	5,24	9,76	11
Long-term financial funding and security for DIUs, to focus on innovation (F)	53%	5,35	10,08	12
Focus on short-term innovation milestones with clear scope instead of long-term product strategy within DIUs (S)	32%	6,53	12,15	13

Table 1 – Final Ranking

The empirical results of the third phase can be grouped into three overarching meta-patterns based on the initial meaning and with relation to existing theoretical concepts (see relation in Table 2): (1) *Maintaining Structural Autonomy* (see factors rank 5, 7, 12, 13 in Table 1), (2) *Strategic Boundary Spanning* (see factors rank 1, 2, 3 in Table 1) and (3) *Operational Synchronizing* (see factors rank 4, 6, 8, 9, 10, 11 in Table 1). All three meta-patterns relate broadly to several coping initiatives for paradoxical tensions (e.g. Gregory et al., 2015, Poole and Van de Ven, 1989, Smith and Lewis, 2011).

5 Discussion of Findings

In this study, we investigated factors contributing to effective and symbiotic cooperation between DIUs and MOs. Abstracting from the empirical factors displayed in the preceding section and relating them to existing notions from the literature, we propose three overarching meta-patterns, compiled in Table 2.

Maintaining Structural Autonomy	**Strategic Boundary Spanning**	**Operational Synchronizing**	
Factors that aim sustaining the structural autonomy of DIUs by fostering divergence in objectives, working and organizing.	*Factors that aim at bridging the boundaries between DIUs and MOs by fostering their integration in the upper echelons and strategic agendas of the organization.*	*Factors that aim at synchronizing the practices of DIUs and MOs operationally by fostering the alignment of offerings, interfaces and values.*	*Derived description of meta pattern*
Focus on digital products and services with high-added value. Thinking and acting in short-term milestones rather than long-term products. Adaptable and flexible organizational structures within DIUs.	Introduction of a strategic advisory board in the MO with structural bridge to the MO. Strategic TMT support towards DIUs. DIUs' strategy and vision derived from overall strategy of MO.	Collaborative value creation and joint portfolio development and operationalization. Incentivized collaboration and co-worker transfer between DIUs and MOs. DIU and MO employees interact and meet as equals while avoiding personal power games.	Panelists' factors – empirical results
Optimized and well-established organizational structures of incumbent organizations are ill-suited for acquiring digital prowess or cultivating DIs (Yoo et al., 2012), creating a tension between belonging and innovating. Firms adopt post-bureaucratic organizational forms, unshackling themselves from constraints to concentrate on DI while keeping their heritage (Svahn et al., 2017).	Segregated governance structures and processes between physical and digital units hinder the combination of their outcomes (Hylving and Schultze, 2020). Contrasting strategic focus in resource planning, budgeting horizons, and business orientations reduces decision abilities (Jöhnk et al., 2022, Henfridsson and Bygstad, 2013, Vega and Chiasson, 2019)	Contrary rules and routines between physical and digital focused units aggravate operationally linked practices and combined outcomes (Hylving and Schultze, 2020). Cultural differences and lack of understanding causes friction during joint development initiatives (Visnjic et al., 2021).	Related tensions from literature
Innovation focus vs. heritage	Separated specialization vs. integrated combination	Flexibility vs. long-term planned activities	Derived key-tension from literature

Table 2 – Meta-Patterns

Maintaining Structural Autonomy. The meta-pattern of *Maintaining Structural Autonomy* subsumes factors to ensure and sustain the DIUs' structural demarcation from the MO to develop novel DI-related capabilities. The pattern's factors serve and promote the structural aspect of separation in the spirit of "a 'second speed' [...] function by keeping the emerging logic separate from the existing ideas" (Tumbas et al., 2018). It focusses on the maintenance of this separation. *Maintaining Structural Autonomy* becomes particularly visible through four different factors. First, to encourage a certain autonomy, the organizational structures within DIUs should be designed to be adaptable and flexible (see factor 7 in Table 1). Secondly, there should be a *focus on digital products with high added value and high innovation in the DIUs* (see factor 5 Table 1). Thirdly, thinking and acting in short-term milestones rather than long-term products should be supported (see factor 13 Table 1). Additionally, a certain level of financial stability is necessary to maintain an undivided focus on DI (see factor 12 Table 1). The focus on DI can be facilitated by structurally decoupling individual units from the restrictions and shackles of the MOs (Svahn et al., 2017, Tumbas et al., 2018). A narrowed focus in these units enables a rise in innovation power and exploration skills, culminating in novel digital capabilities (Svahn et al., 2017, Yoo et al., 2012). In this context, both the approach of short and iterative milestone cycles and the use of post-bureaucratic organizational forms constitute factors that increase the focus on DI (Hund et al., 2021). Concluding, *Maintaining Structural Autonomy* permits the uninterrupted growth and expansion of digital capabilities, as well as the focused creation of digital components. Separated units

can develop and institutionalize post-bureaucratic organizational procedures, strategies, and work cultures that enable organizations to transcend hierarchical constraints and enable a greater emphasis on DI (Svahn et al., 2017, Yoo et al., 2012). Further, by maintaining structural segregation and autonomy against the cultural and structural pull of the existing heritage, this meta-pattern may assure the sustainability and longevity of DIUs (Svahn et al. 2017).

Strategic Boundary Spanning. The meta-pattern *Strategic Boundary Spanning* subsumes factors to enable an intentional and coordinated integration of DIUs with the goal of establishing a new unified whole, that is, an adapted organization of which the DIU and the MO become a part and contribute to their overall goals. *Strategic Boundary Spanning* becomes visible through three distinct factors with a strategic, top-down orientation. The most relevant factor in our study suggests the introduction of an *advisory board in the MO and a structural linkage to the top management of the MO*. Such a platform provides space for strategic coordination and orchestration and can serve as a central element in blending two distinct demands (Gregory et al., 2015). Battilana et al. (2014) define organizational "spaces of negotiation" (Battilana et al., 2014) as a vital boundary-spanning factor between segregated units. The factor ranked as second most critical - *DIUs' strategy and vision derived from overall strategy of MO to avoid (uncoordinated) co-existence* - reveals the importance of strategic alignment to build trust and joint sensemaking (Weick, 1995). The third boundary-spanning factor identified by our experts is the strategic support of DIUs by the MOs' top management (see factor 3 in Table 1). While top management support is by no means a new issue in change processes or innovation topics (e.g. Bantel and Jackson, 1989), the high ranking nevertheless demonstrates the importance of this factor. TMT support is seen as particularly relevant in times of DI, as the TMT – recently described as "pluralist managers" (Besharov, 2014) - not only need to expand the existing business, but in addition to presenting themselves as a thought leader, supporter, and facilitator of new technologies, are incorporating a highly relevant role as an enabler of digital innovation (Firk et al., 2021). Spanning the boundary between the "old" and the "new" world of an organization, the TMT can serve a bridging role (Tumbas et al., 2018), especially in the context of ambidexterity, as previously elaborated by Raisch and Birkinshaw (2008). Further, symbiotic and sustainable corporation between two separated units requires a strategical orchestrating and moderation authority that structurally spans between boundaries and creates a new unified whole (Chanias et al., 2019, Hylving and Schultze, 2020). To summarize, *Strategic Boundary Spanning* may alleviate tensions originating in separate governance structures for physical and digital product units (Hylving and Schultze, 2020), as well as in independent sets of organizational norms and standards (Henfridsson et al., 2009). Additionally, it can reconcile divergent priorities in resource planning, budgetary negotiations, and purpose (Svahn et al., 2017) through a strategic and boundary-spanning integration.

Operational Synchronizing. The meta-pattern of *Operational Synchronizing* subsumes factors to enable a practical alignment of value-creation underpinned by a reciprocal acceptance and appreciation between DIUs and MOs to link distinct work practices. Our third meta-pattern, *Operational Synchronizing*, becomes visible through six individual factors. In detail, collaborative value creation (see factor 6 in Table 1) and joint practical portfolio development and operationalization (see factor 9 in Table 1) between DIUs and MOs are deemed particularly advantageous for the cooperative development of DIs since they enable the resolution of tensions in the early conception and development stages of DI (Hylving and Selander, 2012, Dremel et al., 2017). Instead of laboriously combining two individually developed artifacts, competencies can thus be pooled right at the beginning of value creation (Hylving and Schultze, 2020). Rotation between DIU and MO workers, identified in the literature as a significant transformation driver (Raabe et al., 2020), may be used as an instrument to facilitate early cooperation in practice (see factor 10 in Table 1). Further, the structural and organizational introduction of incentives for a joint collaboration between DIUs and MOs is considered relevant (see factor 4 in Table 1). An introduction of incentives to engage a specific action is a common tool to resolve tensions, e.g., on joint organizational learning and knowledge transfers (Smith and Beretta, 2021), on an organization-wide strategic DI engagement (Danneels and Viaene, 2022), or on changing business logics (Tumbas et al., 2018). Further, in addition to strategic and operational alignments, our experts consider cultural alignments and mutual understanding relevant. The alignment of understanding (Karpovsky and

Galliers, 2015) in the process of dynamic problem-solving and decision-making is defined as a core competency for successful DI management (Nambisan et al., 2017). Further, cultural alignments and mutual understanding can be characterized as necessary preconditions for partnership work (Visnjic et al., 2021). The experts explicitly state that DIU and MO employees should interact and meet as equals (see factor 8 in Table 2) while avoiding personal power games between the two entities (see factor 11 in Table 2). To avoid anxiety and negativity, building relationships and cultivating social interaction is seen as highly relevant in the contexts of two separate business models (Visnjic et al., 2021). It can be anchored in the literature of organizational culture and indicates the relevance of social factors in the innovation process (e.g. Lokuge et al., 2019, Boland et al., 2007) and in the facilitation of ambidextrous settings (Raisch and Birkinshaw, 2008). Concluding, *Operational Synchronizing* may aid in resolving tensions that originate in distinct value-creation cycles (e.g., McKinsey, 2020, Porsche-Consulting, 2020) or cultural differences and a lack of reciprocal understanding (Visnjic et al., 2021). Additionally, it may assist in aligning two poles to facilitate the operational and procedural integration of physical and digital components inside layered modular product architectures (Hylving and Schultze, 2020).

In Figure 1, we illustrate how all three meta-patterns interact and propose a conceptual framework based on our empirical findings and theoretical foundations. Our results suggest that, in line with prior research, effective and mutually beneficial cooperation between DIUs and MOs depends on multiple layers of organizing (Arghavan Shahlaei and Kazan, 2020, Drechsler et al., 2020). Likewise, we identified three layers of organizing, which are mostly consistent with prior studies. Our meta-patterns reveal (1) a *structural layer*, (2) a *strategic layer*, as well as (3) an *operational layer*. We conceptualize that one layer (1) maintains the structural segregation between DIUs and MOs (Figure 1, a) and that two layers (2&3) strategically and operationally synthesize DIUs and MOs (Figure 1, b). Drawing inspiration from the modular DI architecture (Yoo et al., 2010) as the underlying product-architecture, we refer to the combination of our meta-patterns and organizational architecture as *Multi-Layered Organizing* (Figure 1, c).

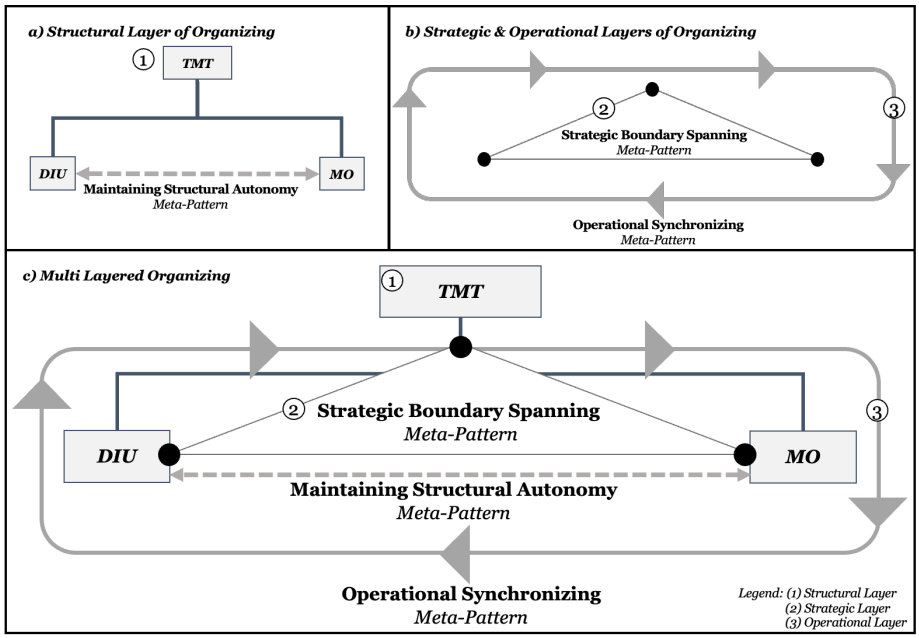

Figure 1 – Layers of Organizing

6 Synthesis

In a further abstraction of our findings, we can identify connections to the theory on paradoxes and ambidexterity (Gregory et al., 2015, Smith and Lewis, 2011, Raisch and Birkinshaw, 2008). Considering our panellists' replies and the existing theoretical foundations, we derive a continuing need to *Maintain Structural Autonomy* to meet the demands of DI. This resembles the ambidextrous capability of

establishing and sustaining a new contradictory pole to enable a distinct focus on innovation activities (Smith and Tushman, 2005, O'Reilly and Tushman, 2004). Yet, to overcome the underlying inherent tensions of layered-modular DI (Hylving and Schultze, 2020), we need to go beyond the separation-oriented perspective of ambidexterity (Papachroni et al., 2014). By strategically integrating DIUs into MOs, our second meta-pattern, *Strategic Boundary Spanning*, provides *blending* capabilities to mitigate paradoxical tensions (Gregory et al., 2015). Further, the third meta-pattern, *Operational Synthesizing*, might overcome paradoxical tensions by *balancing* both poles (Gregory et al., 2015) and linking DIUs and MOs on an operational level. In detail, the meta-pattern *Maintaining Structural Autonomy* contributes to sustaining a structurally segregated and autonomous unit and to resist the bureaucratic influences from the MO heritage. Following ambidexterity research, it is comparable to the application of separation to enable two poles with an unique and undivided focus (Smith and Tushman, 2005). Applying the paradoxical perspective on ambidexterity yet, it seems as if this meta-pattern is insufficient and only a first step, allowing for an initial boost in exploratory potential but requiring an additional synthesizing approach once the DI outcomes or new capabilities need to be transferred into the MO (Smith and Lewis, 2011). The meta-pattern *Strategic Boundary Spanning* contributes to the coupling between DIUs and MOs. Existing ambidexterity research underlines a comparable need for establishing orchestrating structures, strategies, and integrating leadership activities (Raisch and Birkinshaw, 2008), to transcend segregated ambidextrous poles (Tumbas et al., 2018, Smith and Tushman, 2005, O'Reilly and Tushman, 2004). It provides “a clear strategic intent, an overarching vision and values, and an aligned senior team with the ability to manage trade-offs as organizational ambidexterity’s most relevant antecedents” (Raisch and Birkinshaw, 2008). Regarding the paradox perspective on ambidexterity, our second meta-pattern is comparable to bridging contradictions between two paradox poles (Lewis, 2000). Further, developing a mutual perspective in strategy allows “to reframe the tension from a trade-off to a paradox perspective” (Visnjic et al., 2021). The meta-pattern *Operational Synchronizing* contributes to the linkage between DIUs and MOs. Regarding the theory of ambidexterity, this resembles the need to establish cross-functional linkages and interfaces on an operational firm level, to align knowledge, value-creation and teams as proposed by Jansen et al. (2009). From a paradoxical perspective on ambidexterity the application of this meta-pattern enables two different domains (i.e., DIUs and MOs) to not be seen in a battle between professions (Abbott, 1988), but to provide interlinked pathways which may result in the mitigation of paradoxical tensions between two separated units (Smith and Lewis, 2011).

Concluding, prior research, as well as our panellists’ replies, anticipate that adopting a paradoxical perspective on ambidexterity can move our understanding beyond the dominant separation-oriented prescriptions (Papachroni et al., 2014, Smith and Beretta, 2021, Smith and Lewis, 2011). Taken together, our three meta-patterns underscore the assertion by Andriopolous and Lewis (2009) "that integration and differentiation offer powerful, complementary tactics for fostering ambidexterity, [as] this combination helps reduce the anxiety and defensiveness that tensions spark and that can spur vicious, rather than virtuous, cycles" (Andriopoulos and Lewis, 2009). Yet, approaches to resolving tensions can thus trigger new tensions, as “(o)ne challenge is the possibility that the resolution of one paradox may inadvertently create another” (Poole and Van de Ven, 1989). This requires providing practices for recurrent tensions on a more operational/bottom-up level while reacting to new arising tensions through the same paradox lens on a more strategic/top-down level, (Visnjic et al., 2021). Hence, it seems all the more relevant to constantly consider the lens of paradox iteratively and dynamically (Visnjic et al., 2021, Papachroni et al., 2014) not only in recognizing tensions but also in resolving them (Smith and Lewis, 2011).

7 Theoretical and Managerial Implications

Our findings contribute to several streams of literature. First, we contribute to the ongoing research on DI and discuss ways in which it emerges and is integrated into traditional organizations (Nambisan et al., 2017). We focus on incumbents' capacity to combine digital and physical components generated in two independent units (Svahn et al., 2017), which is seen as an extremely relevant but nascent part of

our field (Ciriello et al., 2018, Hund et al., 2021). Further, we deepen knowledge on layered-modular DI by adding necessities and possibilities for organizational integration practices that result from this architecture (Yoo et al., 2010). To cope with the converging digital and physical boundaries (Hund et al., 2021), organizational boundaries, i.e., those between two separated units, converge as well. Through proposing our *Strategic Boundary Spanning* and *Operational Synchronizing* meta-patterns, we describe how these converging processes occur on several layers of organizing. Researchers noticed this relation between product architecture and organizational structure before and defined it as *mirroring hypothesis* (e.g. Hylving et al., 2012, Colfer and Baldwin, 2016). It postulates a structural similarity between the design of a complex product and the organizational structure responsible for its manufacture and maintenance (Colfer and Baldwin, 2016). Our research demonstrates this notion by describing various layers of organizing between DIUs and MOs, comparable to a layered modular product structure. In this regard, we contribute to research on changing organizational forms following Hanelt et al., (2021), who observe a "shift towards malleable organizational designs which enable continuous adaptation" (Hanelt et al., 2021a). We, therefore, provide a further jigsaw piece to the big picture of recent organizational designs. Applying the paradox perspective on ambidexterity (Gregory et al., 2015, Papachroni et al., 2014), we shed light on specific hybrid forms of organizing triggered by the adoption of digital technologies (Schumm and Hanelt, 2021). We contribute by demonstrating that this widely used perspective may also create and contribute significantly to IS and, more particularly, DI research since, as Gregory et al. (2015) argue, resolving paradoxical-ambidextrous tensions becomes especially critical in the digital age. We, therefore, enhanced existing integration concepts of the ambidexterity research stream (e.g., Raisch and Birkinshaw, 2008) by focussing on the specific challenges of DIUs and their MOs. Lastly, we contribute to the emerging literature of DIUs, by providing collaboration approaches and ideas on how to overcome intraorganizational boundaries and structure the ambidextrous settings of digital innovation units (e.g. Haskamp et al., 2021, Raabe et al., 2020). We add strategic, structural, and operational integration mechanisms to ambidextrous DIU research and enhance the existing perspective (e.g., Holotiuk and Beimborn, 2019).

For practitioners, the results have concrete applicability. First, managers who reflect on realizing digital capabilities and building DIs internally can be inspired by our research focus and warned by the theoretically derived tensions. Second, managers who work in or collaborate with DIUs may utilize our prioritized list of key factors (table 1) as quick wins to elaborate on internal interfaces. Thirdly, managers and organizations interested in establishing a DIU may use our meta-patterns as a blueprint and therefore consider: a) sufficient breathing room for innovation; b) joint strategies and the formation of a mutual TMT board; and c) mutual operational value creation, for example through joint innovation projects.

8 Limitations and Future Research

Our study is not without limitations. First, we focused on the automotive industry and only a very generalized perception of DIU types. Despite offering an interesting field of research, its nature imposes certain limitations on the generalizability. Second, our results are based on a limited number of experts, although we have made the highest efforts to ensure an appropriate panel size. The number of participants complies with other Delphi studies, which built on a lower (Nambisan et al., 1999, Daniel and White, 2005) or a comparable (e.g. Piccinini et al., 2015, Kasi et al., 2008) panel size. Future research may extend our study by integrating experts from both poles. Another future research avenue is the practical application of the paradoxical perspective on the already existing literature on ambidexterity, and the derivation of concrete coping strategies for paradoxical tensions, as this is a nascent part of our IS field (Ciriello et al., 2018, Hund et al., 2021). Future research can build upon the existing concepts of ambidexterity literature and further improve integration approaches by adopting the paradox-perspective (e.g., Gregory et al., 2015, Raisch and Birkinshaw, 2008). We engage further studies to build on our meta-patterns and add specifying details from further practical investigations. While we consider our results generalizable, future research can expand upon our findings by examining other types of hybrid organizations beyond those involving DIUs. Additionally, exploring different forms of DIUs with varying boundaries and structures can help to broaden this growing field of inquiry.

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