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Characteristics, Antecedents, and Consequences of Agile R&D Units' Organization – A Conceptual Framework

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Abstract: *The information systems and operations management fields have exhaustively investigated the concept of agility. However, innovation management literature has almost neglected the topic, particularly agile R&D units, on which large industrial companies increasingly rely. To investigate this practically relevant but academically under-explored phenomenon's characteristics, antecedents, and consequences, we conducted an explorative-qualitative study with R&D managers and agility experts. Our findings' integration in extant literature provides a holistic framework of agile R&D units' organization (ARDO). The results reveal the complementary capabilities to gain agility and facilitate future empirical investigations, thus advancing scarce research on agility's capability perspective in innovation management.*

Keywords: agile R&D units, organizational agility, R&D, new product development

1. Introduction

"We are now really in the process of generating ideas in the innovation phase before the product development process, and the speed that can be achieved with agile working is enormous. I would never have thought that this is possible." (interviewed R&D Manager 4)

Such practitioner insights made agile methods highly relevant in software development firms (Denning, 2016). But also industrial firms increasingly embrace the concept to gain increased adaptability to changing business environments (Cooper & Sommer, 2016; Rigby, Sutherland, & Takeuchi, 2016). Consequently, agility attracted academia's attention, mainly in information systems and operations management research. Extant research investigated agile methods' usage (Fitzgerald, Hartnett, & Conboy, 2006; Wang, Conboy, & Pikkarainen, 2012), agility's drivers and outcomes (see Tallon, Queiroz, Coltman, & Sharma, 2019 for an overview), and the agile enterprise (Bottani, 2010; Yusuf, Sarhadi, & Gunasekaran, 1999) or supply chain (Gligor, Esmark, & Holcomb, 2015; Swafford, Ghosh, & Murthy, 2006).

However, agility research in R&D and innovation management is surprisingly scarce. Yet, precisely in this context, agility might be most relevant because uncertainty is high, and employees from different functional backgrounds work on vaguely-defined product ideas (Kock, Heising, & Gemünden, 2015). Agility's principles explicitly address this fuzziness and provide the required adaptability in the innovation process (Kester, Griffin, Hultink, & Lauche, 2011; Kester, Hultink, & Griffin, 2014).

In large firms, R&D units—nested in the firm's or business unit's R&D department—typically carry out these innovation-related tasks and face the elaborated difficulties (Globocnik & Salomo, 2015; Markham, 2013; Schrauder, Kock, Baccarella, & Voigt, 2018). These units conduct unit-level innovation management activities (such as portfolio management) and perform research or product development activities. In this context, R&D units' agile organization and the resulting agility comes into play because R&D activities especially call for increased adaptability (Gonzalez, 2014; Kock & Gemünden, 2016; Vinodh, Aravindraj, Pushkar, & Kishore, 2012). As part of a firm's operative structures, R&D units contribute to the firm's organizational agility and affect its overall success (Kock et al., 2015; Markham, 2013; Schrauder et al., 2018).

Despite R&D units' need for agility and their overall importance, extant R&D and innovation management literature neglected the practically highly relevant phenomenon of agilely organized R&D units and failed to holistically investigate agility's antecedents and outcomes

in the R&D context. For example, Shuradze, Bogodistov, and Wagner (2018) considered the concept only in a mediating role, primarily examining data analytics capabilities' effect on key innovation outcomes. Moreover, extant research only considered a narrow set of agility's antecedents (Cai, Liu, Huang, & Liang, 2019; Kester et al., 2011; Kester et al., 2014; Kock & Gemünden, 2016).

More importantly, most of these studies conceptualize agility only as an outcome (i.e., increased adaptiveness). However, we can also perceive agility as a capability (i.e., how to organize to be agile) (Bouwman, Heikkilä, Heikkilä, Leopold, & Haaker, 2018). Similarly, Cooper and Sommer (2016) regard "Agile" as a management approach (a capability) that facilitates agility (the outcome) in new product development. Extant studies applying such a capability perspective solely concentrate on agile approaches' application (Beaumont, Thuriaux-Alemán, Prasad, & Hatton, 2017; Bianchi, Marzi, & Guerini, 2020; Cooper & Sommer, 2016). However, observations from practice and literature show that agility encompasses more than just iterative working (Lee & Xia, 2010). For example, agility is highly customer-centric and relies on empowered employees from different functions (Denning, 2018; Sheffield & Lemétayer, 2013; Yusuf et al., 1999). So, in addition to iterative approaches, agility should also consider the customer relationship, the work environment, and team-compositional aspects.

Consequently, research on agile R&D units and their organization could shed more light on this relevant phenomenon. More importantly, studying their characteristics would give further insight into the structures, capabilities, and culture necessary for being agile and successful in R&D. In addition, applying a system perspective to ARDO would be fruitful to identify the interplay between its dimensions and their antecedents and consequences. Identifying antecedents allows examining contingencies and requirements that support ARDO's development. Elucidating ARDO's consequences demonstrates its relevance for innovation success in physical product development and thus complements the holistic framework.

To the best of our knowledge, no previous study examined agility's characteristics, antecedents, and consequences in the context of R&D, let alone regarding the organization of agile R&D units in a large industrial firm. We thus define our study's research questions as followed: *What are the characteristics of agile R&D units' organization (ARDO)? What are antecedents that enable or hinder ARDO? What are ARDO's consequences?*

We conducted a qualitative-exploratory study at a multinational electronics and engineering firm to address these research questions. We contrast the empirical findings with extant literature to discuss consistencies and differences and derive a holistic framework of ARDO. For the paper's remainder, we define ARDO as an R&D unit's organizational capability, combining cultural, structural, and process-based resources to increase the unit's adaptiveness toward changing environments. Complementary to this capability perspective, we define agility from an outcome perspective as a unit's increased adaptiveness toward changes of any kind (Cai et al., 2019; Kester et al., 2014; Kock & Gemünden, 2016).

Our study contributes to extant agility research in R&D and innovation management (Cai et al., 2019; Kock & Gemünden, 2016) because we approach the concept from a new perspective, in a new context, and via a new unit of analysis. While there already is empirical evidence on individual aspects of the framework (e.g., Cooper & Sommer, 2016), our results advance these insights because they provide a holistic system perspective on agility's characteristics, antecedents, and consequences. By explicitly applying a capability perspective (Bouwman et al., 2018), our study provides answers to the question of how to organize and which complementary capabilities to possess to gain agility. Our study's holistic view reveals various new antecedents and barriers of the concept and provides further insights on aspects that previous literature only marginally addressed.

Our study is original because it studies agile R&D units in an industrial setting and thus responds to previous agility research's corporate, individual project, and software development focus (Gligor et al., 2015; Sheffield & Lemétayer, 2013; Tallon et al., 2019). We thus initially investigate the concept's application in permanent organizational units that execute physical products' R&D. This paper contributes to R&D and innovation management literature because it sheds light on the highly relevant phenomenon of agile R&D units and provides deeper insights into the interplay between agility and innovation success. In this respect, we provide qualitative evidence on ARDO's effect on innovation performance and introduce ARDO as a new antecedent of NPD success (Sivasubra-

maniam, Liebowitz, & Lackman, 2012). Furthermore, the developed framework is a foundation of quantitative research on agility in the R&D and innovation management field from a capability perspective, since it inter alia facilitates the development of a scale to measure ARDO and thus the model's empirical validation.

2. Method

2.1. Research design

Since previous literature has neglected agile R&D units, and the transfer of insights from other fields might not entirely capture agility in R&D's context-specific aspects, we followed an explorative approach as suggested by Edmondson and McManus (2007). The research design consisted of three distinct steps.

First, we conducted a qualitative-explorative study similar to other work in organizational theory (Khanagha, Ramezan Zadeh, Mihalache, & Volberda, 2018) and innovation management (Andriopoulos, Gotsi, Lewis, & Ingram, 2018). Consequently, we identified various factors to characterize agile R&D units, different aspects that support or hinder their agile organization, and ARDO's potential outcomes.

Second, as Strauss and Corbin (1998) recommend, we carried out an extensive analysis of literature on organizational agility explicitly after data collection to avoid a biased, theory-based attitude. The review provided an overview of characteristics, enablers, barriers, and potential agility outcomes in other research fields. In this respect, we also considered other adaptability-enhancing concepts (e.g., ambidexterity or organizational learning).

In a third step, we contrasted our interviews' case-specific findings to aspects describing, enabling, and hindering organizational agility or similar concepts found in the literature. The same applies to the outcomes. This process resulted in a holistic overview of ARDO's characteristics, antecedents, and consequences.

2.2. Data collection

We gathered the empirical material in a multinational electronics and engineering firm, which contains various legally independent business units with product portfolios varying from automotive to household electronics and hydraulic components. The company employs over 400.000 associates in approximately 60 countries, generates a sales revenue of nearly 80 billion euros a year, and is well known for its innovativeness. The company was the ideal setting to better understand agile R&D units in an industrial setting because of its innovation orientation, extensive portfolio of physical products, and its pioneering role in agility.

The exploratory study included twelve semi-structured interviews with agility experts (e.g., agile coaches and change experts with a specific R&D background) as well as R&D managers from R&D units that use agile approaches. Informants stemmed from six distinct business units and two central departments, all located within one country. Following purposeful sampling (Corbin & Strauss, 1990; Strauss & Corbin, 1998) and counseled by three practitioners and an internal list of agility experts, we selected highly knowledgeable informants from various hierarchical levels. Sampling then evolved into snowballing since the informants identified other knowledgeable individuals. With this selection process and by focusing on informants with diverse backgrounds, we reached theoretical saturation after twelve interviews. Before this point, the interviews' content started to resemble one another, yielding no further insights (Corbin & Strauss, 1990; Strauss & Corbin, 1998). The interviews had an average length of 45 minutes and were recorded and transcribed to ensure common scientific standards (Strauss & Corbin, 1998).

2.3. Data analysis

The first author coded all the interview data using the approach of Gioia, Corley, and Hamilton (2013), a common practice in inductive research (Smith & Besharov, 2019). Right after the first two interviews and to set a common standard, the second author and one additional researcher challenged his judgments, resulting in the coding scheme's continuous refinement.

The data analysis process started by performing initial open coding. We applied in-vivo codes (Strauss & Corbin, 1998)—informants' specific wording—to label relevant interview content (e.g., words or paragraphs). Various second-order themes emerged based on the derived first-order codes and axial coding (Corbin & Strauss, 1990; Strauss & Corbin, 1998). Gioia et al.'s (2013) approach concludes by systematically connecting the emerged second-order themes (e.g., culture, work method) to aggregate dimensions that describe the examined phenomenon's overarching aspects

(e.g., agile R&D units' characteristics). We also presented the resulting Gioia tables to three practitioners of the firm to ensure content validity.

3. Results

In the following sections, we first elaborate on ARDO's characteristics, followed by the enablers and barriers that, respectively, support or hinder its development. Finally, we discuss ARDO's potential outcomes. Expressive quotes illustrate the different aspects, which the corresponding Gioia tables summarize (Figure 1-4).

3.1. Characteristics of agile R&D units' organization

Findings indicate that six elements characterize ARDO (see Figure 1). The first is its specific *structure*. According to the informants, these units are significantly smaller than common R&D units. The entire organization solely focuses on the company's success. This includes a constantly changing structure that adapts to the specific tasks at hand. Many of these units have agile structures but can also apply traditional methods if needed. The main factor describing ARDO's structure is a reduced number of hierarchical levels. One agility expert explains:

"Flat hierarchies make the information and decision-making processes quite short, and much is left to where the actual work is done." (AE 5)

An agile R&D units' culture is characterized by high team orientation, motivation, self-organization, and low status orientation. Moreover, employees value respect, openness, courage, focus, and commitment, and they live an open-minded and change-embracing mindset. Furthermore, a specific way of dealing with failure seems to prevail. Mistakes are not considered harmful but rather a source of learning.

"Agile development is different; it lives on a trial and error principle. Now to the culture: we have to manage it, or we managed it with [company] that we allow to make mistakes." (RM 5)

Due to their *cross-functional capabilities*, agile R&D units have all the needed capabilities in their ranks, and members practice interdisciplinary collaboration intensively. Role descriptions are flexible in these units, and unit members generally understand related areas next to their in-depth expertise. Consequently, they can support and replace one another during absenteeism. R&D manager 3 exemplified this fact:

"Now two controllers became unavailable [in my unit], which means I am also doing controlling again. That is what I mean. I have a different core task, but everyone is looking "left and right." Because everyone focuses on one goal…"

Agile R&D units' *customer integration* sometimes even results in the co-development of products. According to the informants, these units focus more intensively on the product they want to develop and the customer they want to satisfy than other R&D units. They seek high customer proximity with constant and direct feedback. Customers are treated as partners in the development process, and strong collaboration often means that they immediately verify initial ideas and product changes. The responsiveness to customers' needs is, therefore, more pronounced than in non-agile R&D units. Agility expert 5 remarked: *"A strong customer focus, the customer is everything."*

Increased *autonomy* gives agile R&D units the authority to structure and staff themselves as needed and adopt processes diverging from the company's standards. This autonomy results in the unit's high responsibility and capabilities for self-organization. However, besides the unit's autonomy from the rest of the company, managers also provide unit members increased autonomy and responsibility because unit members decide relevant issues mutually.

"They [the unit members] have full decision-making authority over which functionalities they pack in [the product] and which markets they approach and which they do not, and can make these decisions by themselves, without consulting seven people." (AE 2)

ARDO's *work method* is characterized by flexible working conditions, granted time for innovation, and high task transparency. Furthermore, internal and external collaborations are more pronounced. Evident is the use of agile methods and artifacts, including daily stand-ups, retrospectives, a common workspace, and a backlog to structure tasks. Most vital, however, is the iterative, feedback-driven work in sprints. Agility expert 2 described the agile work method:

"Agile working includes this very strong feedback-driven approach, which, in my opinion, is the core of innovation development. When I create an innovation, I try it out. I do something uncertain. I do not know if it will work

out, and then I have to go out as early as possible to my customers to get their feedback. Then I adapt the product, adapt the approach, adapt my business model, whatever. That is agile working for me."

In summary, these characteristics seem to collectively describe ARDO. The interviewees also stressed that, even though they are distinct attributes, they depend on one another and that it is necessary to consider all of them to gain full agility. R&D Manager 3 exemplified this complementarity:

"One does not work without the other; for example, you cannot change an organization from, say, classical hierarchical thinking and standard processes to agile if the culture does not change simultaneously … It is more about how can I organize and structure a unit in such a way that the overall system benefits from it."

Also agility expert 6 stressed that the ARDO dimensions are complementary when resuming his view on agile R&D units' characteristics: *"So the whole deal: such an agile organization must consider all dimensions so that you can implement it."*

3.2. Enablers of agile R&D units' organization

The interview data also revealed enabling factors that support R&D units to transition from classical structures to ARDO (see Figure 2). First, *top management support* (i.e., senior executives' support, management attention, and a direct link to the top management) benefits the transition process. Individuals in upper management can also act as role models or even participate in the transition activities.

"One example: I was now at [another company] that has a management board of three people. They created a new position in the management board, which exactly promotes this specific topic [agility], and they have…hired a person who has experience in the field of change [management] and agility and directly appointed him to the management board. To give the topic a signal effect. To make sure it progresses. Enormously important!" (AE1)

Second, early *success stories* further support the R&D units' reorganizations. Fact-proved benefits or successfully developing a superior product with a strategic, highly relevant customer are particularly beneficial. Agility expert 1 described this approach in re-organizing his R&D unit:

"We started to approach an important strategic project with an [agilely-organized] team ... and then we proved that the topic agility makes us more flexible by what we create. We implemented what the customer wanted, and there we practically saved money ... If this first project had failed, the transition could have been forgotten."

Third, concerning *involvement of the employees,* the interviews revealed that an agile organization's setup was more successful when all unit members vigorously participated or even initiated the changes themselves. This involvement often happened when people better understood the agile roles and agility's benefits.

"Speaking about agility, when I built up the organization … I took [employee 1] and [employee 2], the ones who understood the topic, who were motivated, and we built the thing together. Otherwise, we would have had no chance, without multipliers, without a hand of people, such a topic cannot be mastered." (RM6)

Fourth, the *availability of resources* shows investments' importance to provide the required infrastructure and tools. These include Kanban-boards, visualization mediums, and software tools but foremost, the presence of an own workspace or room.

"What is often forgotten ... is the importance of a home, also in a spatial context. You somehow need a room. That was beneficial for us … This is really one of the most important things that became apparent." (RM4)

Fifth, ARDO's successful setup also benefits from a *structured approach*, including various aspects and practices that the informants have noted as helpful. Initially, a bottom-up approach with all relevant departments' involvement (e.g., Human Resources) seemed helpful. Informants also reported the benefits of a step-by-step introduction with fixed deadlines and transparent communication of goals and the sense of urgency. This process includes agile roles' clear definition right from the start. Moreover, informants emphasized a start with pilot teams, a supportive transition team setup, and the transfer of agile method competencies. Sometimes, even personnel changes are necessary, but always in consideration of the unit's overall team dynamic, composition, and all unit members' skills, as R&D manager 4 remarked:

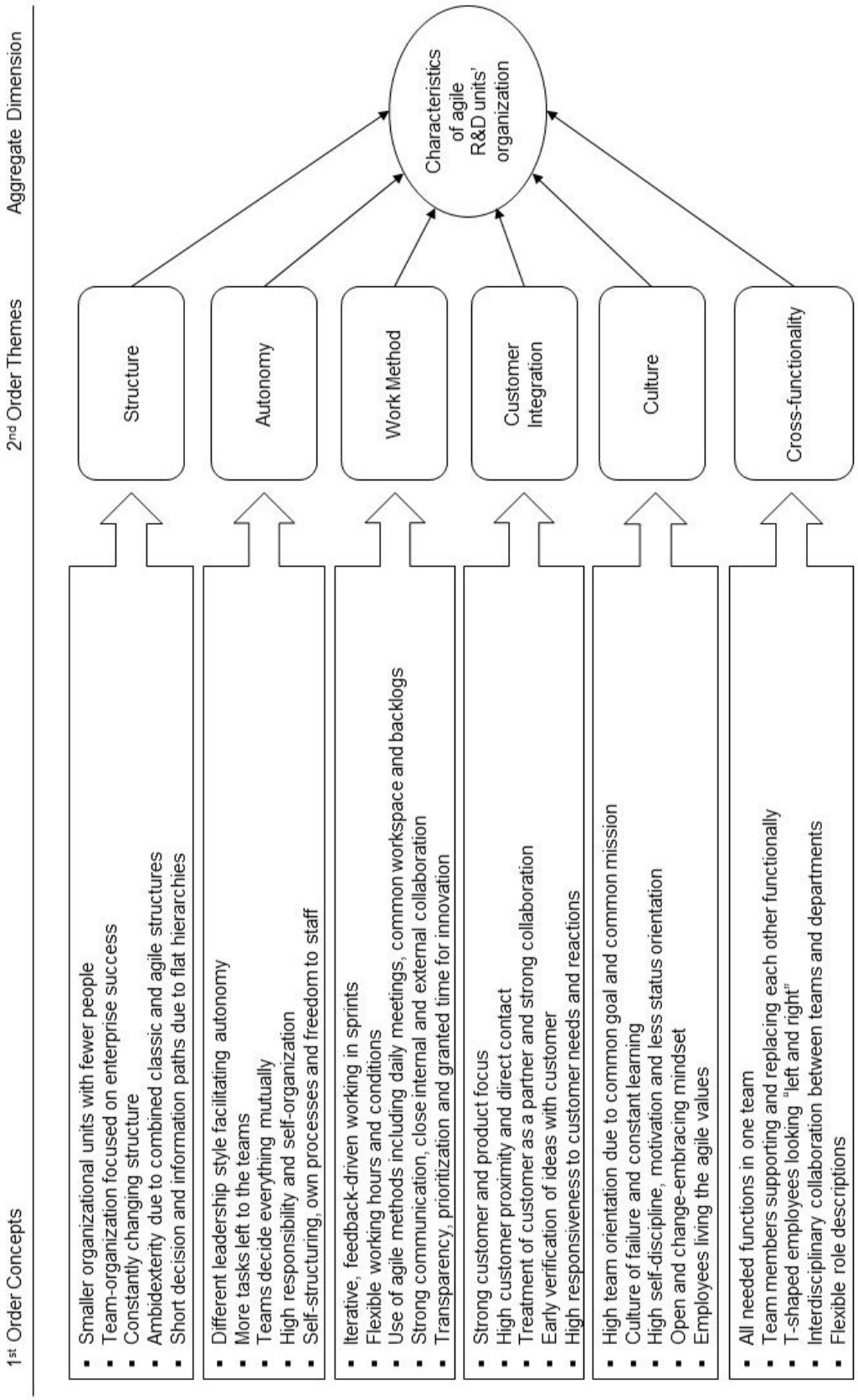

Figure 1: Gioia table - characteristics of agile R&D units' organization

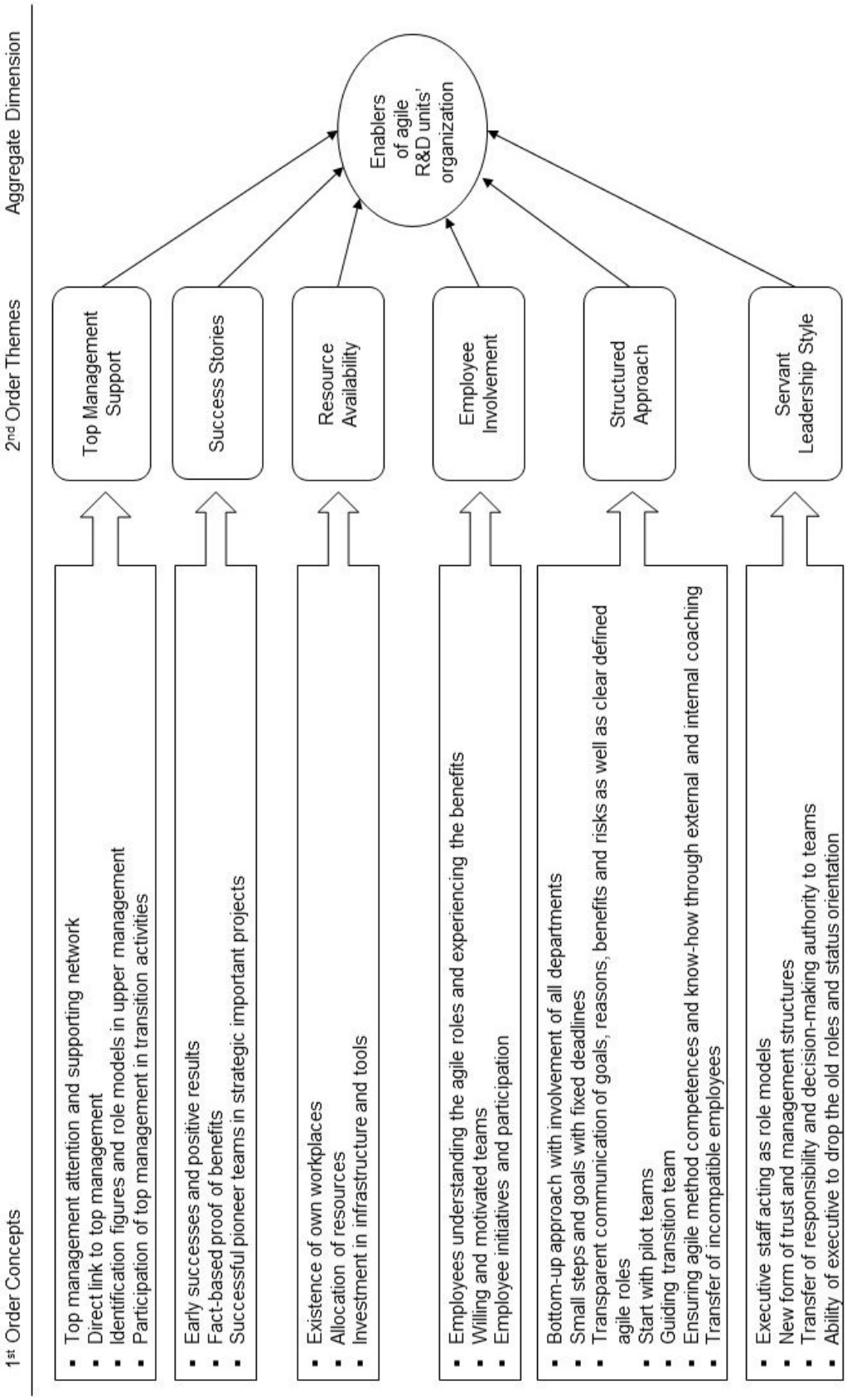

Figure 2: Gioia table - enablers of agile R&D units' organization

"Some people are just happy when they have their defined scope and know what they will do the next day and then do it well. These people get problems because they cannot handle team dynamics. However, that is not a bad employee; you really have to be careful. They are good associates, but they do not like community, team, and agile, and you have to be careful not to lose them. You have to find a solution ... These are often the pillars of such groups or units."

Finally, a *servant leadership style* based on mutual trust transfers responsibility and decision-making authority to the units. This leadership type requires R&D managers' ability to act as role models and let go of old status orientation.

"I think in the new leadership style, the executive staff must create something similar to a relationship of trust with the employees ... to challenge them, but also to trust them that something reasonable will evolve ... So the topic of leadership as a mixture of incentive/ motivation/coaching and not precise micromanagement." (RM1)

3.3. Barriers of agile R&D units' organization

The interviews also revealed ARDO's specific barriers (see Figure 3). First, *classic human resources (HR) systems* and their corresponding processes are often incompatible with how these organizational units operate. The HR departments additionally fail to promote participation in agile R&D units. Clear role descriptions and corresponding evaluation criteria are lacking, making career paths in an agile environment ambiguous and less profitable.

"... what was also very bad in the beginning for us: the roles were unclear, and the career paths were extremely ambiguous. People want to progress and if it is not clear how to make a career here, then that is a real problem." (RM4)

Second, the *misapplication of agility* also negatively influences agile R&D units' persistence. For example, some R&D units often call themselves "agile" only to respond to top management directives but keep their old ways of working. The return to previously established methods and organizational forms as a response to early failure is another issue. An additional challenge is that agile approaches are hard to align with increased unit size and that they are often applied to all types of business activities, even if inappropriate, which leads to agility's negative perception if objectives are not met. Agility expert 5 remarked:

"That [the general application of agile methods on all projects] was [company]'s biggest mistake in the beginning, by the way, and they ruined the word [agility] with it. Until they have learned that you cannot work agile everywhere."

Third, the *executive staff* often misinterprets agility, its values, principles, and potential outcomes. The informants addressed a lack of support and commitment to the organizational changes, originating from the unit leaders' personal goals and fear of losing control. Nonetheless, even if the R&D unit leaders advocate the transition, sometimes missing authority (e.g., to allocate the needed resources) hinders reorganizations.

"Well, it [the agile transition] has to be wanted by the executive staff. If the manager does not want it, you can forget it right away." (AE 6)

Fourth, *missing internal and external compatibility* further challenges agile R&D units and includes, on the one hand, the cooperation with non-agile organized departments and external partners, such as customers and suppliers. On the other hand, existing corporate guidelines, including an oversized reporting system, hinder agile R&D units. R&D manager 6 stated:

"The other barriers that strongly hinder us are the very rigid company processes. The company processes are right now designed for clear line organization. The processes are designed for large series, large volume production, completely different."

Finally, sometimes *fear of change* prevails in R&D units. The values and principles agility comprises, along with the less appreciated roles, sometimes cause challenges. For example, some employees perceive constant contact as unpleasant and a privacy limitation interfering with their comfort zones. Transparency of tasks and work status furthermore exposes low performers.

"The biggest impediment is actually always the people. Do the people go along with it? To inspire and win the people is the biggest challenge … Because many people say we want to be agile, but then really to bear the consequences, to change, that is very difficult." (AE3)

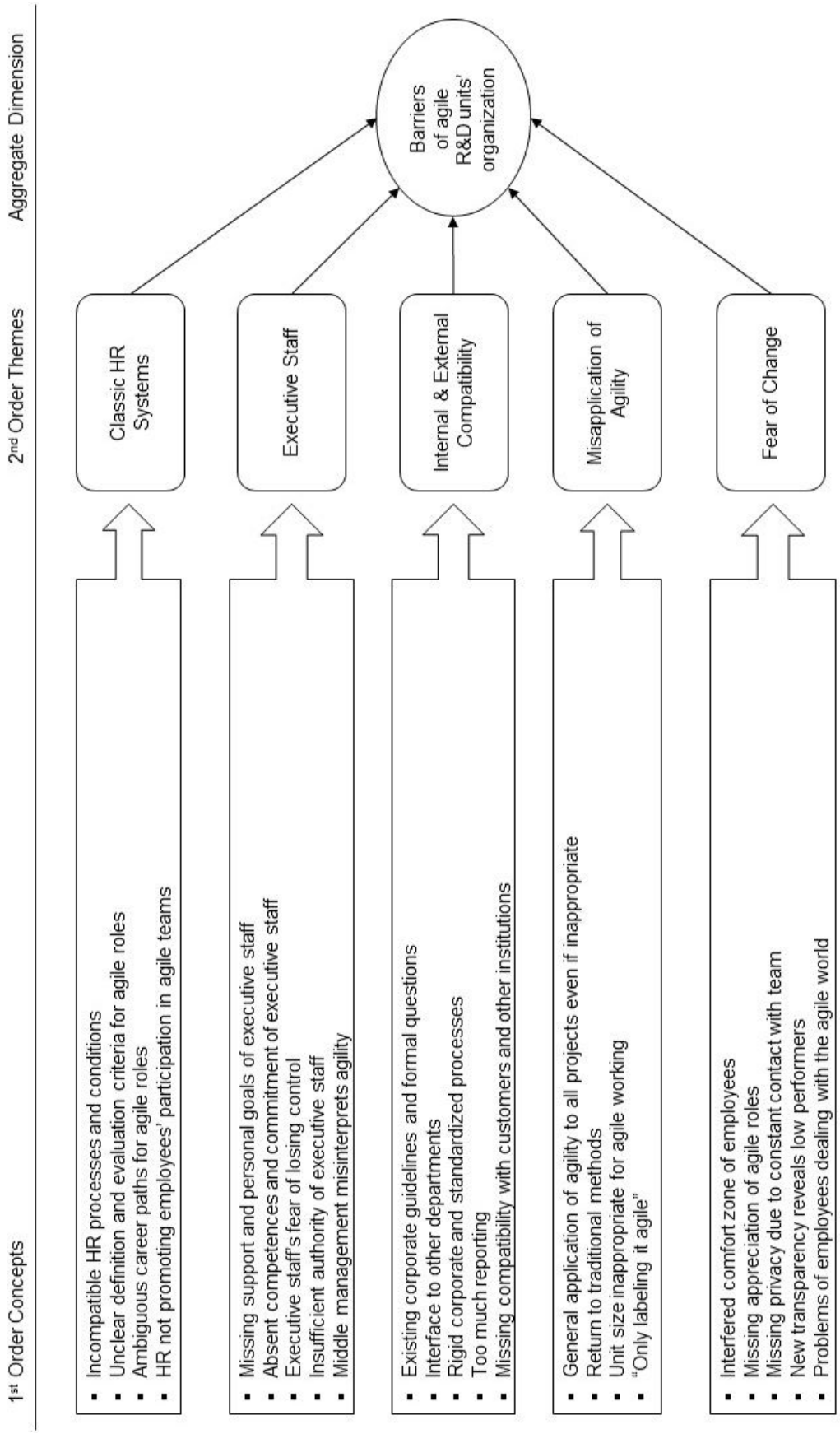

Figure 3: Gioia table - barriers of agile R&D units' organization

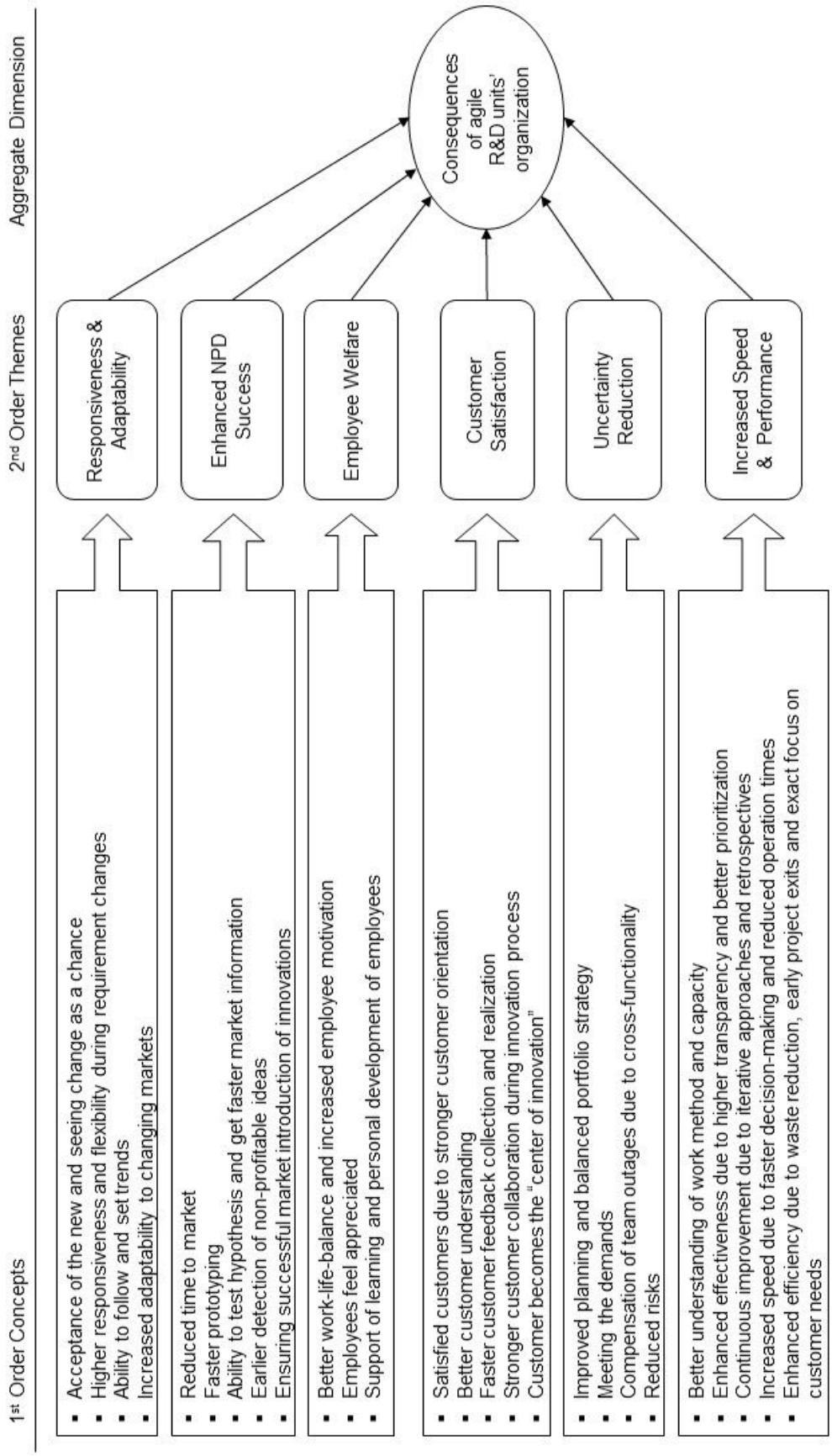

Figure 4: Gioia table - consequences of agile R&D units' organization

3.4. Consequences of agile R&D units' organization

The interviews also revealed the consequences of agilely organized R&D units (see Figure 4). The informants emphasized increased *responsiveness* and *adaptability*, essential to react quickly in constantly changing markets. ARDO seems to lead to a faster acceptance of change as an opportunity rather than a threat. Agility expert 2 summarized this ARDO consequence: *"The ability to be responsive and successful in an uncertain environment."*

ARDO also seems to favor *new product development (NPD) success*. Faster prototyping and immediately testing hypotheses about products and customers are particularly beneficial. The immediate customer feedback enables non-profitable ideas' early detection. The R&D managers confirmed that their units' agile organization reduced time-to-market significantly and strongly contributed to various innovations' market introduction.

"... how fast you can accelerate the maturity of a prototype and see if the business model works or not. I claim that you cannot do that any better than by working agile. That is such an immense progress. I am very excited about that." (RM4)

ARDO also favors *employee welfare* since it provides various benefits for a unit's employees. Informants noted an increase in motivation, satisfaction, and appreciation. The values and principles agility implies often contribute to a better work-life balance, learning, and personal development. Agility expert 1 remarked:

"I have never seen developers' eyes glow the way as when the customer tells them: "[company], I never thought you would deliver something like this after two or three sprints." This is reflected in everything, the working-time accounts, the reduced absent days, the enthusiasm, the dynamism, the atmosphere in the coffee kitchen, etc."

Uncertainty reduction is another outcome because the flexibility ARDO provides facilitates improved planning and enhanced meeting of demands. Prioritizing and early exiting projects lead to a more balanced portfolio strategy. Compensating outages through the unit's cross-functional composition further reduces uncertainty. Agility expert 3 highlighted this outcome of ARDO: *"Risk minimization. That is what you actually do it for. All this learning is actually just about risk reduction."*

ARDO also results in *increased speed* and *performance*, thus improving the unit's effectiveness and efficiency. Better understanding the work method and capacity, higher transparency, and rigorous prioritization of tasks increase effectiveness. Moreover, working iteratively and using retrospectives lead to continuous improvement. Waste detection, early projects exits, and the focus on customer needs further enhance effectiveness. Moreover, the R&D unit's speed increases due to faster decision-making and tasks' reduced operation time. R&D manager 4 stressed this:

"We are now really in the process of generating ideas in the innovation phase before the product development process, and the speed that can be achieved with agile working is enormous. I never would have thought that this is possible."

Finally, ARDO can also improve *customer satisfaction* because the inherent customer orientation provides a more profound understanding of customer needs. Collecting and implementing immediate feedback lead to faster product delivery. As stated by agility expert 6, ARDO achieves that "*the customer becomes the center of the innovation."*

4. Discussion and framework development

In the following, we contrast the empirical findings to insights on agility and other adaptability-enhancing concepts from the literature. The resulting framework depicts ARDO's characteristics, antecedents, and outcomes. In keeping with Bouwman et al. (2018), our framework jointly considers agility's capability perspective (i.e., how to organize to be agile) and its outcome perspective (i.e., increased adaptability and responsiveness). In line with our interviews' results and extant literature (Vázquez-Bustelo, Avella, & Fernández, 2007; Vinodh et al., 2012), we theorize that the way agile R&D units are organized enhances their agility, which, as an intermediate outcome, improves the more distal consequences.

4.1. Characteristics of agile R&D units' organization

A central characteristic of agile R&D units is their high autonomy. This finding is consistent with literature investigating agile enterprises' or agile project management's attributes (Gonzalez, 2014; Sheffield & Lemétayer, 2013; Yusuf et al., 1999). Even though stemming from other research fields, these insights support our findings. The relevance of autonomy for ARDO

also fits past research in the field of organizational resilience (Richtnér & Löfsten, 2014; Richtnér & Sodergren, 2008) and adaptive NPD teams (Andriopoulos et al., 2018; Grass, Backmann, & Hoegl, 2020; Patanakul, Chen, & Lynn, 2012), reinforcing autonomy's consideration as an ARDO characteristic.

The findings on customer focus's relevance are also consistent with prior research (Bottani, 2010; Gunasekaran, 1998; Lu & Ramamurthy, 2011), which also refers to flat hierarchies as vital elements of organizational agility (Teece, Peteraf, & Leih, 2016), agile manufacturing (Vinodh et al., 2012) and organizational learning (Huang, Rode, & Schroeder, 2011). However, our interviews also revealed aspects regarding agile R&D units and thus agility that literature has not addressed yet. For example, agile working can also imply a constantly changing and ambidextrous unit structure, which facilitates switching between traditional and agile methods depending on the task. Nevertheless, we included flat hierarchies in our framework since most informants considered them as the most essential structural characteristic.

Prior research also reports that cross-functionality is a key element of agility-related constructs (Bottani, 2010; Khanagha et al., 2018; Patanakul et al., 2012; Stettina & Hörz, 2015; Yusuf et al., 1999). We extend this literature by the aspect that, besides the different functional backgrounds, all unit members also possess widespread knowledge in related areas. This allows them to support and replace one another, an aspect that prior research has not addressed. Our findings thus add to extant agility research by identifying this T-shapedness (Hansen, 2001) as cross-functional collaborations' vital element in an agile setting and question prior findings that solely focused on different functions' integration.

Also, our investigations regarding ARDO's work method revealed new insights. For example, while past research highlighted iterative, feedback-driven approaches as relevant for agility (Cooper & Sommer, 2016; Gonzalez, 2014; Sambamurthy, Bharadwaj, & Grover, 2003), it overlooked aspects such as flexible working conditions and granted time to work on own ideas. This elucidates new insights regarding agility's work method and suggests that these aspects are particularly relevant for agility in the context of R&D because they might favor creativity.

Our study also provides new insights regarding an agility-supporting culture. Our concept–ualization of ARDO's culture fits extant literature addressing a culture of change (Bottani, 2010), team-orientation, dedication, commitment (Patanakul et al., 2012; Stettina & Hörz, 2015), as well as friendship, support, and trust (Gibson & Birkinshaw, 2004; Richtnér & Sodergren, 2008) as key aspects of a change-embracing culture. In this respect, it is notable that most informants labeled some of these principles as agile values, which, however, differ from the agile manifesto's values (Beck et al., 2001). Indeed, extant literature designates ethics such as courage etc., which our informants addressed, more as Scrum values (Madi, Dahalin, & Baharom, 2011). This suggests that a different understanding of agile values may exist in an industrial setting since the original ones might focus too much on software development. Our findings further reveal failure tolerance as a vital cultural aspect of ARDO. Prior research did not address this aspect, which is surprising considering failure tolerance's importance for agility's trial and error approaches. Consequently, our interviews ascertained failure tolerance as an important cultural element of agility.

Extant literature also addressed additional agility characteristics such as increased innovativeness, reduced time-to-market, and adaptability (Bottani, 2010; Sharifi & Zhang, 2001; van Oosterhout, Waarts, & van Hillegersberg, 2006). However, most studies and our informants identified these factors as agility's outcomes, which is why we also treat them as such. This clear separation of ARDO's characteristics, antecedents, and outcomes again shows the benefits of applying a system perspective on ARDO.

4.2. Antecedents of agile R&D units' organization

The literature review revealed consistencies but also new insights regarding our findings and agility's enablers and barriers. The consistencies include top management support (Hobbs & Petit, 2017; Hornsby, Kuratko, Holt, & Wales, 2013; Sheffield & Lemétayer, 2013), resource availability (Lu & Ramamurthy, 2011; Nerur, Mahapatra, & Mangalaraj, 2005; Tallon et al., 2019), employee involvement (Hobbs & Petit, 2017; Vinodh et al., 2012), and a servant leadership style (Bäcklander, 2019; Chen, Ravichandar, & Proctor, 2016; Vinodh et al., 2012). This favors their integration in the framework. However, it is notable that some studies just list various enablers without any

further explanation (e.g., Vinodh et al., 2012). In this respect, our findings are valuable because the Gioia table's first-order codes provide deeper insights into each factor.

Noteworthy is the structured approach to implement ARDO, which relies on coaching, a supporting transition team, and the start with pilot teams. This fits past research (Chen et al., 2016; Hobbs & Petit, 2017; Schatz & Abdelshafi, 2005), even though these studies often just sporadically addressed these elements. However, our informants also highlighted new best practices, such as the necessity of clear role descriptions, the unavoidable transfer of inappropriate employees, and the early involvement of all relevant departments, particularly HR. Thus, our study elaborated a best-practice approach to managing the agile transition, which literature by now failed to provide, and discovered a new antecedent of agility.

The literature review identified a firm's IT capability as a vital agility enabler (Bottani, 2010; Lu & Ramamurthy, 2011; Tallon et al., 2019), while a missing IT conformity and inappropriate IT tools are often stated barriers (Boehm & Turner, 2005; Nerur et al., 2005; van Oosterhout et al., 2006). This is mainly caused by extant agility literature's focus on information systems. Since our informants did not address these aspects, we will not consider them in the framework.

Concerning agile enterprises' challenges, our findings fit extant literature's insights. However, it is notable that research regarding agility's barriers is scarce compared to studies investigating its characteristics, enablers, or outcomes. Moreover, literature often addressed the identified barriers scarcely or not at all, which once more endorses our study's approach to investigate ARDO's enablers and barriers simultaneously and in greater depth.

While Boehm and Turner (2005) also revealed process-related HR issues, our results extend their insights by pointing out unclear career paths and the missing promotion of agility by HR as additional barriers. Prior research also reports employees' change resistance (Boehm & Turner, 2005; Chen et al., 2016) as a potential barrier. Nevertheless, it failed to address an interfered comfort zone, low performers' revealing, privacy issues, and agile roles' missing appreciation, which foster employees' fear of change and thus the change resistance.

While prior research further addresses the executive staff's misinterpretation of agility and missing competencies as impediments (Rigby et al., 2016), our results show that even if top management advocates changing to ARDO, the transition sometimes fails because managers lack authority. This finding once again shows autonomy's importance for agility on every organizational level because typically, these managers' ability to pass authority is considered a vital issue (Nerur et al., 2005).

The interviews also revealed several mistakes leading to agility's misapplication, which prior literature did not address (Schatz & Abdelshafi, 2005). In addition, the interviews also showed agility's missing internal and external compatibility (Boehm & Turner, 2005; Chen et al., 2016; Hobbs & Petit, 2017; van Oosterhout et al., 2006). Thus, our framework includes both aspects.

4.3. Consequences of agile R&D units' organization

Our interviews' findings are consistent with studies addressing agility's outcomes. Our results link ARDO to increased efficiency (Gligor et al., 2015; Raschke, 2010; Serrador & Pinto, 2015; Yang, 2014), effectiveness (Gligor et al., 2015; Maruping, Venkatesh, & Agarwal, 2009), NPD performance (Cooper & Sommer, 2016; Rigby et al., 2016; Vázquez-Bustelo et al., 2007), and employee satisfaction (Cooper, 2016; Rigby et al., 2016; Tripp, Riemenschneider, & Thatcher, 2016).

However, our study also revealed consequences that prior research has overlooked so far. While Strode, Hope, Huff, and Link (2011) state that agile methods are designed to handle uncertainty, we extend these insights since our interview data provide first empirical evidence on this relationship, introducing uncertainty reduction as a new outcome of agility. In the agile manufacturing context, prior research linked agility to increased customer responsiveness (Gligor et al., 2015; Vinodh et al., 2012) and customer loyalty (Vázquez-Bustelo et al., 2007). Since it might result from the former and, in turn, favor the latter, we open up the "black box" between both elements by providing first evidence on agility's influence on increased customer satisfaction.

Extant literature also highlighted an increased quality as agility's outcome (Maruping et al., 2009; Vinodh et al., 2012), which our informants however did not address. Consequently, since it might not be that relevant in R&D, we did not integrate an increased quality in our framework.

The juxtaposition of our interviews' findings to extant literature revealed several consistencies between ARDO's and organizational agility's characteristics, antecedents, and outcomes. Nonetheless, we also found new elements that previous literature overlooked. Moreover, extant theory primarily covers only one aspect of the emerged second-order themes. In this respect, our first-order codes provide deeper insights into the elements' characteristics. Consequently, our study provides a better understanding of agility in R&D but also advances our understanding of the concept in general, for example, by linking it to new antecedents and outcomes. Figure 5 presents the holistic framework of agile R&D units' characteristics, antecedents, and consequences in an industrial setting.

5. Conclusions

5.1. Theoretical implications

Our study contributes to scarce agility research in the R&D and innovation management field (Cai et al., 2019; Kock & Gemünden, 2016) in several ways because it approaches the concept from a new perspective, in a new context, and via a new unit of analysis.

First, our study provides a holistic view of agility and the necessary capabilities to be agile. Since we have identified all of the framework's factors in one company, our findings allow applying a system perspective and thus thoroughly elucidate the concept's characteristics, antecedents, and outcomes. Thus, our research follows Tallon et al.'s (2019, p. 232) call that "agility does not exist in a vacuum" and extends prior studies that exclusively focused either on antecedents, elements, or outcomes and provided empirical evidence only on selected aspects (Cai et al., 2019; Shuradze et al., 2018; Swafford et al., 2006). Our study is more comprehensive than previous agility research because it combines agility's outcome perspective (i.e., increased adaptiveness) with its neglected capability perspective (Bouwman et al., 2018). This approach thoroughly addresses how to organize for agility and identifies the necessary capabilities, structure, and culture. More specifically, while empirical evidence on the importance of single elements exists, our results suggest that agile R&D units' characteristics, which make them so adaptive, are complementary and interact. This finding suggests that it is necessary to consider them in their entirety to gain full agility and that merely focusing on selected factors is not sufficient. The results question prior work, which, for

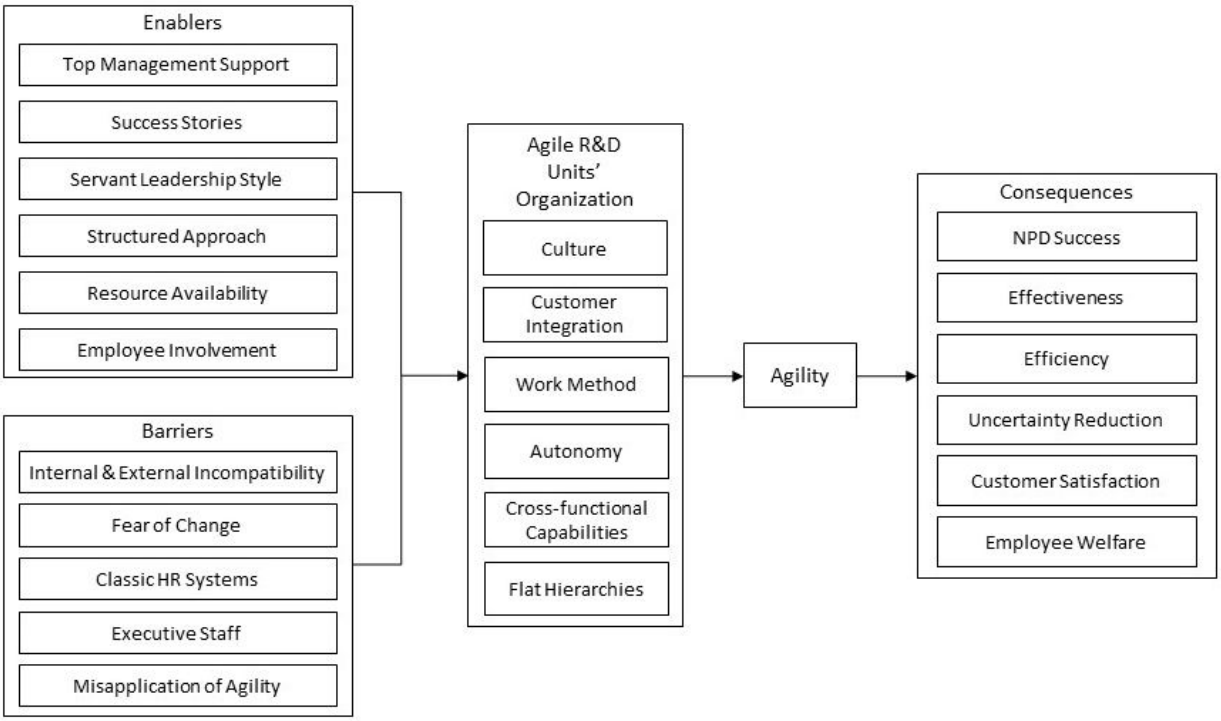

Figure 5: Conceptual framework of the characteristics, antecedents, and consequences of agile R&D units' organization

example, only focused on an iterative work method to increase agility in NPD (Cooper & Sommer, 2016), and indicate that a system perspective is warranted when studying agility.

Second, our study contributes to agility research by detecting new antecedents and outcomes. For example, the interviews revealed a practically proven approach to implement agile R&D units, including several newly discovered best practices such as clear role descriptions, the unavoidable transfer of inappropriate employees, and the involvement of relevant departments (e.g., HR). In addition, we identified employees' fear of change, unclear career paths, and several mistakes leading to agility's misapplication as ARDO's barriers, thus advancing research on agility's antecedents (Kester et al., 2014; Kock & Gemünden, 2016). Moreover, our results show evidence of agility's influence on customer satisfaction and the ability to reduce the prevailing uncertainty in NPD, providing new insights regarding agility's outcomes (Gligor et al., 2015; Tallon et al., 2019).

Third, we aimed at getting an in-depth understanding of each factor. Consequently, our first-order codes provide new insights on each aspect and thus extend knowledge on various framework elements, which prior research addressed only sporadically. For example, we identified failure tolerance as agile culture's key aspect, which is plausible due to agility's trial and error approach, but unaddressed by literature. Our interviews further suggest that the notion of cross-functionality, which agility is often associated with (Yusuf et al., 1999), in agile R&D units also means employees' T-shapedness instead of different functions' mere presence. T-shapedness is usually connected to Design Thinking (Carlgren, Rauth, & Elmquist, 2016), suggesting that the barriers between different user-centric concepts increasingly blur.

Fourth, the current study focuses on agile R&D units in an industrial setting and thus extends research on a corporate or project level (Gligor et al., 2015; Serrador & Pinto, 2015) as well as research in the thoroughly investigated context of software development (Tallon et al., 2019). The current study provides first insights into agility's application in industrial R&D's permanent organizational units. Moreover, our study contributes to R&D and innovation management literature by initially investigating the practically highly relevant phenomenon of agile R&D units on which large industrial firms nowadays increasingly rely. By elucidating ARDO's influence on key innovation activities, we provide deeper insights into the interplay between agility and innovation success. While prior research has already shown agility's positive relationship with innovation performance (Kester et al., 2014; Shuradze et al., 2018), our study complements these findings by providing new insights on how to gain such increased adaptiveness and further contributes to the wide-ranging discussion on how firms can achieve superior NPD success (Markham, 2013; Sivasubramaniam et al., 2012).

5.2. Managerial implications

Our results provide managers with valuable insights to support agile R&D units. First, our framework offers insights on how they should organize R&D units for agility and the possibility to assess whether and to which degree an organizational unit is agile or not. Furthermore, our conceptual model helps master the transition toward agile R&D units by describing enablers of this process. In this respect, the provided structured approach is a best practice to master such organizational changes successfully. As our study's results provide a comprehensive overview of potential barriers, managers can use these lessons learned to avoid typical pitfalls. The elaboration of agile R&D units' valuable outcomes can support R&D managers promoting and initiating this organizational change.

5.3. Limitations and avenues for future research

This study elaborated various characteristics, antecedents, and outcomes of agilely organized R&D units in a large industrial company. Nevertheless, it is subject to common limitations associated with qualitative research, specifically, its generalizability (Corbin & Strauss, 1990; Strauss & Corbin, 1998). First, even though the focal company possesses a heterogeneous group-like structure, the sample represents only a single company. Therefore, we cannot predict to which extent our findings generalize to other companies, industries, or cultural settings and encourage future studies to investigate agile R&D units' organization in different contexts (e.g., in various cross-national firms within the pharmaceutical industry where R&D also plays a significant role). Second, our study focuses more on economic performance outcomes. Future research could investigate how ARDO, with its own cultural system, influences or interacts with the larger organization's culture and vice versa. Third, we did not explicitly consider the agile R&D units'

maturity level, that is, how far they are in their transition toward an agile organization. Considering such contingencies would allow further insights; for instance, some antecedents might be relevant at the beginning of ARDO's setup but do not play a major role once ARDO has been successfully set up. Future research could apply a more dynamic approach and conduct interviews at various points in time to elucidate how the ARDO framework evolves, for example, if new outcomes, such as increased quality, evolved.

Despite these limitations, our results are highly relevant for scholarship and provide additional directions for further research. The derived ARDO dimensions and the corresponding first-order codes allow developing multiple survey items to thoroughly capture each dimension and create a comprehensive scale to measure ARDO and simultaneously to identify agile R&D units. The resulting measure thus facilitates further quantitative investigations, for example, the validation of ARDO's positive effect on innovation performance. In doing so, our model could help extend scarce organizational agility research in innovation management and specifically establish more research applying a capability perspective on agility, which is rare in the present literature. Moreover, the identified antecedents and consequences are a starting point to detect further, not yet considered, aspects.

When discussing our results, also similarities between ARDO and the dynamic capabilities concept, which prior research already linked to organizational agility (Teece et al., 2016), evolved. Dynamic capabilities refer to a "firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece, Pisano, & Shuen, 1997, p. 516). According to Teece et al. (2016, p. 29), "[s]trong dynamic capabilities can yield organizational agility." Moreover, they link several concepts also found in the ARDO dimensions to the dynamic capabilities' sensing, seizing, and reconfiguring activities. For example, sensing is about hypotheses building regarding the future and learning, which highly relies on observing the customer, for example, through customer integration. Seizing refers to getting tasks done, whereby the authors identify hierarchy as agility's enemy and recommend a flatter organizational structure. In addition, transforming counts on minimum viable products' continuous delivery, for example, through iterative working.

However, Teece et al.'s (2016) notion of dynamic capabilities and organizational agility refers to the firm level and describes a general ability across several task domains. ARDO, in contrast, refers to an organizational capability of an R&D unit, which results in increased adaptiveness toward changes. Nevertheless, the alignment of prior conceptual works and this study's findings provide several arguments that ARDO is a context-specific manifestation of dynamic capabilities in R&D and innovation management. First, Teece et al. (2016) describe dynamic capabilities as a central enabler of a firm's organizational agility and, in line with this, ARDO too is a capability, resulting in increased agility, albeit on the R&D unit level. Second, Teece et al. (2016) divide dynamic capabilities in a firm's sensing, seizing, and reconfiguring/transforming activities and consider it an overarching latent construct relying on these dimensions. The same refers to our ARDO conceptualization along six distinct dimensions. Finally, taking a closer look at the concepts that Teece et al. (2016) describe as relevant for sensing, seizing, and transforming reveals high similarities to the identified ARDO dimensions.

Based on these theoretical rationales and considering the multi-dimensional nature of dynamic capabilities (Teece et al., 1997; Teece et al., 2016), future studies could corroborate our assumption that ARDO represents an overarching, latent construct, for example, by showing high correlations between the dimensions in a quantitative study. In this respect, ARDO's conceptualization could be a basis for developing a multi-dimensional measurement scale and thus facilitates future quantitative studies. Moreover, future research could investigate prior conceptual works in greater depth or conduct additional qualitative investigations to clarify our suggestion of ARDO being a context-specific manifestation of dynamic capabilities in R&D and innovation management. In sum, the framework developed in this study is a starting point to establish more quantitative research on agility in the R&D and innovation management field, particularly from a capability perspective.

References

Andriopoulos, C., Gotsi, M., Lewis, M. W., & Ingram, A. E. (2018). Turning the Sword: How NPD Teams Cope with Front-End Tensions. Journal of Product Innovation Management, 35(3), 427–445.

Bäcklander, G. (2019). Doing complexity leadership theory: How agile coaches at

Spotify practise enabling leadership. Creativity and Innovation Management, 28(1), 42–60.

Beaumont, M., Thuriaux-Alemán, B., Prasad, P., & Hatton, C. (2017). Using Agile approaches for breakthrough product innovation. Strategy & Leadership, 45(6), 19–25.

Beck, K. M., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J., & Thomas, D. (2001). Manifesto for agile software development. Retrieved from https://agilemanifesto.org/

Bianchi, M., Marzi, G., & Guerini, M. (2020). Agile, Stage-Gate and their combination: Exploring how they relate to performance in software development. Journal of Business Research, 110, 538–553.

Boehm, B., & Turner, R. (2005). Management challenges to implementing agile processes in traditional development organizations. IEEE Software, 22(5), 30–39.

Bottani, E. (2010). Profile and enablers of agile companies: An empirical investigation. International Journal of Production Economics, 125(2), 251–261.

Bouwman, H., Heikkilä, J., Heikkilä, M., Leopold, C., & Haaker, T. (2018). Achieving agility using business model stress testing. Electronic Markets, 28(2), 149–162.

Cai, Z., Liu, H., Huang, Q., & Liang, L. (2019). Developing organizational agility in product innovation: the roles of IT capability, KM capability, and innovative climate. R&D Management, 49(4), 421–438.

Carlgren, L., Rauth, I., & Elmquist, M. (2016). Framing design thinking: The concept in idea and enactment. Creativity and Innovation Management, 25(1), 38–57.

Chen, R., Ravichandar, R., & Proctor, D. (2016). Managing the transition to the new agile business and product development model: Lessons from Cisco Systems. Business Horizons, 59(6), 635–644.

Cooper, R. G. (2016). Agile–Stage-Gate Hybrids: The Next Stage for Product Development Blending Agile and Stage-Gate methods can provide flexibility, speed, and improved communication in new-product development. Research-Technology Management, 59(1), 21–29.

Cooper, R. G., & Sommer, A. F. (2016). The Agile-Stage-Gate Hybrid Model: A Promising New Approach and a New Research Opportunity. Journal of Product Innovation Management, 33(5), 513–526.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. Qualitative Sociology, 13(1), 3–21. https://doi.org/10.1007/BF00988593

Denning, S. (2016). How to make the whole organization “Agile”. Strategy & Leadership, 44(4), 10–17.

Denning, S. (2018). How major corporations are making sense of Agile. Strategy & Leadership, 46(1), 3–9.

Edmondson, A. C., & McManus, S. E. (2007). Methodological fit in management field research. Academy of Management Review, 32(4), 1246–1264.

Fitzgerald, B., Hartnett, G., & Conboy, K. (2006). Customising agile methods to software practices at Intel Shannon. European Journal of Information Systems, 15(2), 200–213.

Gibson, C. B., & Birkinshaw, J. (2004). The antecedents, consequences, and mediating role of organizational ambidexterity. Academy of Management Journal, 47(2), 209–226.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking Qualitative Rigor in Inductive Research. Organizational Research Methods, 16(1), 15–31.

Gligor, D. M., Esmark, C. L., & Holcomb, M. C. (2015). Performance outcomes of supply chain agility: When should you be agile? Journal of Operations Management, 33-34(1), 71–82.

Globocnik, D., & Salomo, S. (2015). Do formal management practices impact the emergence of bootlegging behavior? Journal of Product Innovation Management, 32(4), 505–521.

Gonzalez, W. (2014). Applying Agile Project Management to Predevelopment Stages of Innovation. International Journal of Innovation and Technology Management, 11(4), 1–21.

Grass, A., Backmann, J., & Hoegl, M. (2020). From Empowerment Dynamics to Team Adaptability: Exploring and Conceptualizing the Continuous Agile Team Innovation Process. Journal of Product Innovation Management, 37(4), 324–351.

Gunasekaran, A. (1998). Agile manufacturing: Enablers and an implementation framework. International Journal of Production Research, 36(5), 1223–1247.

Hansen, M. T. (2001). Introducing T-Shaped Managers. Harvard Business Review, 79(3), 106–116.

Hobbs, B., & Petit, Y. (2017). Agile methods on large projects in large organizations. Project Management Journal, 48(3), 3–19.

Hornsby, J. S., Kuratko, D. F., Holt, D. T., & Wales, W. J. (2013). Assessing a Measurement of Organizational Preparedness for Corporate Entrepreneurship. Journal of Product Innovation Management, 30(5), 937–955.

Huang, X., Rode, J. C., & Schroeder, R. G. (2011). Organizational structure and continuous improvement and learning: Moderating effects of cultural endorsement of participative leadership. Journal of International Business Studies, 42(9), 1103–1120.

Kester, L., Griffin, A., Hultink, E. J., & Lauche, K. (2011). Exploring portfolio decision-making processes. Journal of Product Innovation Management, 28(5), 641–661.

Kester, L., Hultink, E. J., & Griffin, A. (2014). An empirical investigation of the antecedents and outcomes of NPD portfolio success. Journal of Product Innovation Management, 31(6), 1199–1213

Khanagha, S., Ramezan Zadeh, M. T., Mihalache, O. R., & Volberda, H. W. (2018). Embracing Bewilderment: Responding to Technological Disruption in Heterogeneous Market Environments. Journal of Management Studies, 55(7), 1079–1121.

Kock, A., & Gemünden, H. G. (2016). Antecedents to Decision-Making Quality and Agility in Innovation Portfolio Management. Journal of Product Innovation Management, 33(6), 670–686.

Kock, A., Heising, W., & Gemünden, H. G. (2015). How ideation portfolio management influences front-end success. Journal of Product Innovation Management, 32(4), 539–555.

Lee, G., & Xia, W. (2010). Toward agile: an integrated analysis of quantitative and qualitative field data on software development agility. MIS Quarterly, 34(1), 87–114.

Lu, Y., & Ramamurthy, K. (2011). Understanding the link between information technology capability and organizational agility: An empirical examination. MIS Quarterly, 35(4), 931–954.

Madi, T., Dahalin, Z., & Baharom, F. (2011). Content analysis on agile values: A perception from software practitioners. Paper presented at the 5th Malaysian Conference in Software Engineering (MySEC). Johor Bahru, Malaysia. Piscataway, NJ: IEEE.

Markham, S. K. (2013). The impact of front-end innovation activities on product performance. Journal of Product Innovation Management, 30(S1), 77–92.

Maruping, L. M., Venkatesh, V., & Agarwal, R. (2009). A Control Theory Perspective on Agile Methodology Use and Changing User Requirements. Information Systems Research, 20(3), 377–399.

Nerur, S., Mahapatra, R., & Mangalaraj, G. (2005). Challenges of migrating to agile methodologies. Communications of the ACM, 48(5), 72–78.

Patanakul, P., Chen, J., & Lynn, G. S. (2012). Autonomous Teams and New Product Development. Journal of Product Innovation Management, 29(5), 734–750.

Raschke, R. L. (2010). Process-based view of agility: The value contribution of IT and the effects on process outcomes. International Journal of Accounting Information Systems, 11(4), 297–313.

Richtnér, A., & Löfsten, H. (2014). Managing in turbulence: how the capacity for resilience influences creativity. R&D Management, 44(2), 137–151.

Richtnér, A., & Sodergren, B. (2008). Innovation projects need resilience. International Journal of Technology Intelligence and Planning, 4(3), 257–275.

Rigby, D. K., Sutherland, J., & Takeuchi, H. (2016). Embracing agile. Harvard Business Review, 94(5), 40–50.

Sambamurthy, V., Bharadwaj, A., & Grover, V. (2003). Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms. MIS Quarterly, 27(2), 237–263.

Schatz, B., & Abdelshafi, I. (2005). Primavera Gets Agile: A Successful Transition to Agile Development. IEEE Software, 22(3), 36–42.

Schrauder, S., Kock, A., Baccarella, C. V., & Voigt, K.-I. (2018). Takin' Care of Business Models: The Impact of Business Model Evaluation on Front-End Success. Journal of Product Innovation Management, 35(3), 410–426.

Serrador, P., & Pinto, J. K. (2015). Does Agile work? — A quantitative analysis of agile project success. International Journal of Project Management, 33(5), 1040–1051.

Sharifi, H., & Zhang, Z. (2001). Agile manufacturing in practice - Application of a methodology. International Journal of Operations & Production Management, 21(5/6), 772–794.

Sheffield, J., & Lemétayer, J. (2013). Factors associated with the software development agility of successful projects. International

Journal of Project Management, 31(3), 459–472.
Shuradze, G., Bogodistov, Y., & Wagner, H.T. (2018). The role of marketing-enabled data analytics capability and organisational agility for innovation: empirical evidence from german firms. International Journal of Innovation Management, 22(4), 1–32.
Sivasubramaniam, N., Liebowitz, S. J., & Lackman, C. L. (2012). Determinants of new product development team performance: A meta-analytic review. Journal of Product Innovation Management, 29(5), 803–820.
Smith, W. K., & Besharov, M. L. (2019). Bowing before dual gods: How structured flexibility sustains organizational hybridity. Administrative Science Quarterly, 64(1), 1–44.
Stettina, C. J., & Hörz, J. (2015). Agile portfolio management: An empirical perspective on the practice in use. International Journal of Project Management, 33(1), 140–152.
Strauss, A. L., & Corbin, J. M. (1998). Basics of qualitative research: Techniques and procedures for developing grounded theory (2nd ed.). Thousand Oaks: Sage Publications.
Strode, D. E., Hope, B., Huff, S. L., & Link, S. (Eds.) (2011). Coordination effectiveness in an agile software development context. Paper presented at the Pacific Asia Conference on Information Systems, Brisbane, AUS. Retrieved from https://aisel.aisnet.org/pacis2011/183
Swafford, P. M., Ghosh, S., & Murthy, N. (2006). The antecedents of supply chain agility of a firm: scale development and model testing. Journal of Operations Management, 24(2), 170–188.
Tallon, P. P., Queiroz, M., Coltman, T., & Sharma, R. (2019). Information technology and the search for organizational agility: A systematic review with future research possibilities. The Journal of Strategic Information Systems, 28(2), 218–237.
Teece, D. J., Peteraf, M., & Leih, S. (2016). Dynamic Capabilities and Organizational Agility: Risk, Uncertainty, and Strategy in the Innovation Economy. California Management Review, 58(4), 13–35.
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, 18(7), 509–533.
Tripp, J. F., Riemenschneider, C., & Thatcher, J. B. (2016). Job satisfaction in agile development teams: Agile development as work redesign. Journal of the Association for Information Systems, 17(4), 267-307.
Van Oosterhout, M., Waarts, E., & van Hillegersberg, J. (2006). Change factors requiring agility and implications for IT. European Journal of Information Systems, 15(2), 132–145.
Vázquez-Bustelo, D., Avella, L., & Fernández, E. (2007). Agility drivers, enablers and outcomes. International Journal of Operations & Production Management, 27(12), 1303–1332.
Vinodh, S., Aravindraj, S., Pushkar, B., & Kishore, S. (2012). Estimation of reliability and validity of agility constructs using structural equation modelling. International Journal of Production Research, 50(23), 6737–6745.
Wang, X., Conboy, K., & Pikkarainen, M. (2012). Assimilation of agile practices in use. Information Systems Journal, 22(6), 435–455.
Yang, J. (2014). Supply chain agility: Securing performance for Chinese manufacturers. International Journal of Production Economics, 150, 104–113.
Yusuf, Y.Y., Sarhadi, M., & Gunasekaran, A. (1999). Agile manufacturing: The drivers, concepts and attributes. International Journal of Production Economics, 62(1), 33–43.

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