How Can CoPs in Scaled Agile Settings Look Like? Toward a Taxonomy for CoPs in Large-Scale Agile Software Development

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Abstract

Fast-changing business environments and customer needs require organizations to react quickly and adapt to changes. While agile software development methods can support organizations in achieving this goal, applying these methods in a large context, like multi-team projects, entails high complexity. Several scaling agile frameworks recommend Communities of Practice (CoP), groups of people with a shared interest that exchange with each other on a regular basis, to support the application of agile at scale, as they can foster, e.g., inter-team collaboration and alignment. Still, no clear overview of aspects that must be considered when establishing and cultivating CoPs in scaled agile settings exists. Therefore, we propose a taxonomy for CoPs in this context, building on literature and findings of an interview study. The taxonomy can support practitioners and researchers, offering a structured overview of aspects relevant to establishing and cultivating CoPs in large-scale agile settings and future research directions.

Keywords: taxonomy, large-scale agile, community of practice

1. Introduction

Nowadays, agile software development methods are widespread in the software development industry (Digital AI, 2023; Dybå and Dingsøyr, 2008). Agile frameworks, such as Scrum, were designed for small, co-located, autonomous teams developing software in close interaction with customers, incorporating regular feedback, and developing in iterations (Kettunen, 2007) - the so-called "agile sweet spot" (Kruchten, 2013). Due to the success of agile methods and their potential benefits, organizations have started to apply them outside of this

mentioned "sweet spot" (Digital AI, 2023; Dikert et al., 2016), for instance, in projects involving multiple teams and across the organization (Dingsøyr and Moe, 2014).

However, scaling agile practices creates various challenges, e.g., regarding dependencies, coordination, alignment, and collaboration (Digital AI, 2023; Dikert et al., 2016). To support organizations in applying agile methods at scale, multiple scaling agile frameworks, like SAFe (Scaled Agile Inc., 2024), were proposed (Uludağ et al., 2021). One of the "tools" that several of these frameworks (Disciplined Agile, 2024; Kniberg and Ivarsson, 2012; LeSS, 2024; Scaled Agile Inc., 2023) recommend for overcoming the mentioned challenges are Communities of Practice (CoPs) - groups of people with a common interest that exchange each other on an ongoing basis (Wenger et al., 2002). According to the frameworks and different studies (Paasivaara and Lassenius, 2014; Šmite, Moe, Levinta, and Floryan, 2019), CoPs can support scaling agile practices successfully as they, e.g., foster alignment and collaboration across the teams and units of the agile organization.

Most existing studies on CoPs in scaled agile settings report insights on how, why, and what communities were established (e.g., Paasivaara and Lassenius, 2014; Tobisch et al., 2024). Some of these studies also describe encountered challenges, impediments, and factors relevant to the success of the communities, highlighting that establishing CoPs poses challenges itself. Overall, there is a lack of a clear and structured overview of relevant aspects (i.e., characteristics) that play an important role when establishing and cultivating CoPs. In general, more research on establishing CoPs in scaled agile settings is needed (Paasivaara and Lassenius, 2014; Tobisch et al., 2024; Uludağ et al., 2022). Thus, we defined the following research question (RQ) to guide our study: *Which dimensions and characteristics must*

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be considered when establishing and cultivating CoPs in scaled agile software development?

To answer this RQ, we developed a taxonomy of CoPs in scaled agile contexts according to Nickerson et al. (2013). In addition, by applying the taxonomy to two examples, we demonstrate its applicability.

The paper is structured as follows: First, we provide a theoretical background on CoPs and their application in large-scale agile settings. Second, we describe our research design and its steps. Then, we present our taxonomy, apply it to two example CoPs, and discuss the taxonomy dimensions referring to theoretical and practical contributions. Finally, we highlight our work's limitations and suggest future research directions.

2. Conceptual background

2.1. Communities of Practice (CoPs)

A CoP can be defined as a group of people sharing a concern, problem, or interest in a topic, deepening their knowledge and expertise through ongoing interactions (Wenger et al., 2002). A CoP is characterized by three core elements (Wenger et al., 2002). The first element is the *domain*, the common interest of the CoP members. The second element is the *community*, the members' interactions, e.g., collaboration, support, or knowledge sharing. The third element is the *practice*, the shared experiences, knowledge, and approaches a CoP creates. CoPs differ from other group structures like formal departments in at least one of the following aspects: their purpose, why people join, their boundaries, why members stay together, and how long they last (Wenger et al., 2002). In the case of a CoP, the purpose is to create and share knowledge and *"develop individual capabilities."* People join based on being an expert or their passion, and the boundaries are unclear. The members stay together because they are passionate and committed and identify with the group and its expertise. CoPs evolve and end if no longer needed.

Organizations implement CoPs due to potential benefits for them and the CoP members (Fontaine and Millen, 2004; Lesser and Storck, 2001; Wenger et al., 2002). Members, e.g., get access to support, expertise, and a network (Wenger et al., 2002). Organizations can benefit from resource reuse, collaboration across units, and positive effects on innovation, strategic capabilities, and efficiency (Fontaine and Millen, 2004; Lesser and Storck, 2001; Wenger et al., 2002).

According to Jassbi et al. (2015) and Wenger et al. (2002), CoPs can have various forms. The communities can differ in their initiation approach, organizational support and recognition, lifetime, scope, member distribution, size, homogeneity, member selection, enrollment, stability, and communication.

2.2. CoPs in scaled agile software development

Scaling agile frameworks, like SAFe (Scaled Agile Inc., 2023) or Spotify (Kniberg and Ivarsson, 2012), recommend the implementation of CoPs, as they allow to connect, exchange, create capabilities across the organization, foster continuous improvement (Disciplined Agile, 2024; Scaled Agile Inc., 2023), and promote self-organization (LeSS, 2024).

Multiple researchers have studied CoPs in large-scale agile software development (e.g., Paasivaara and Lassenius, 2014; Šmite, Moe, Wigander, and Esser, 2019; Tobisch et al., 2024) and report on the potential of CoPs to foster, for example, learning, improvement, mutual support, problem-solving, innovation, alignment, empowerment, and the overall agile transformation. While no study tried to create a taxonomy of CoPs in scaled agile settings, some provided an overview of the studied communities based on different characteristics.

Šmite, Moe, Wigander, and Esser (2019) studied corporate-level communities at Ericsson, intended to support the agile transformation and foster a participative culture. The communities were composed of unit representatives and should promote autonomy, exchange knowledge, and align the organization's distributed units. The authors presented the studied CoPs, differentiating them based on their mission and scope (strategy development, standardization, support with alignment, status monitoring, knowledge sharing), decision-making authority, membership (i.e., size, openness), represented units, and meetings (e.g., frequency).

Šmite, Moe, Levinta, and Floryan (2019) investigated several CoPs at Spotify (so-called "Guilds"), aiming to improve decision-making, support, collaboration, and knowledge sharing across the organization. The authors distinguished the communities based on their core and non-core members, geographical scope, meeting types and frequency, size, value for the organization and members (e.g., access to expertise), and archetypes. The archetypes include book clubs (i.e., focus on learning), open source societies (i.e., focus on improvement and strategy), support lines (i.e., focus on support), and standardizing committees (i.e., focus on alignment).

Paasivaara and Lassenius (2014) studied CoPs at a unit of Ericsson having members distributed at different sites. The authors differentiated the CoPs based on their purpose: knowledge sharing and learning, coordination, technical work, and organizational development.

Monte et al. (2022) conducted a literature review investigating how CoPs can support agile teams. The

authors found different CoP purposes: decentralized decision-making, knowledge exchange, coordination, and support of applying agile methods at scale.

Uludağ et al. (2019) propose patterns for large-scale agile software development. One of these reusable, practice-proven solutions to promote knowledge sharing is CoPs. Thereby, Uludağ et al. (2019) differentiate between voluntary CoPs and mandatory empowered CoPs with decision-making power for different topics.

Finally, Tobisch et al. (2024) conducted an interview study with experts from different large agile organizations, providing insights into the initiation, target group, themes, organizational acceptance, support, decision-making power, steering, participation, scope, and size of the organizations' CoPs. Still, the authors provide an overarching view without structured insights on individual CoPs.

3. Research design

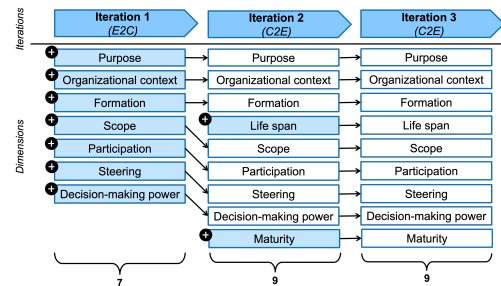### 3.1. Taxonomy development method

This study aims to foster the understanding of relevant dimensions and characteristics of CoPs that can help individuals and organizations establish and cultivate them. Thereby, we focus on the context, initiation, and governance aspects, excluding organizational aspects like meeting frequency. To achieve our objective, we applied a method by Nickerson et al. (2013) (see Figure 1).
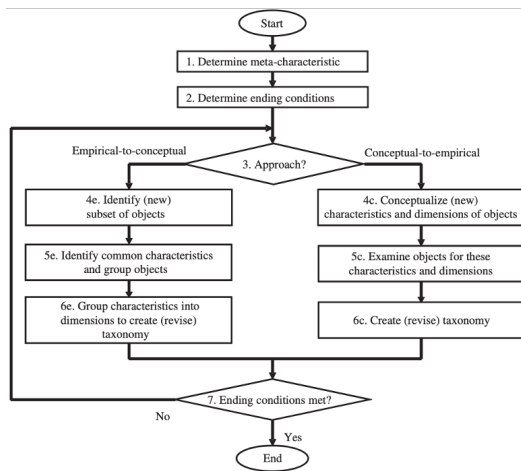
Figure 1. Taxonomy development method by Nickerson et al. (2013)

As an initial step in our taxonomy development process, we defined the following meta-characteristic in line with our RQ: *characteristics of CoPs in scaled agile software development*. Next, we determined subjective and objective ending conditions as proposed by Nickerson et al. (2013). The subjective

ending conditions include the taxonomy being concise, robust, comprehensive, extendable, and explanatory. The objective ending conditions we defined are (i) examination of all objects or a representative sample of objects, (ii) classification of at least one object under every characteristic of every dimension, (iii) no adding, merging, or splitting of dimensions or characteristics in the last iteration, and (iv) unique dimensions. Similar to Jöhnk et al. (2017), we allow non-exclusive characteristics within dimensions to avoid too many characteristics. To avoid too many dimensions, we introduced sub-dimensions. We conducted three iterations to develop our taxonomy (see Figure 2).

Figure 2. Taxonomy development process

We started with an empirical-to-conceptual (E2C) iteration to utilize insights from practice as a starting point. We reviewed and analyzed 39 interviews with experts from 18 large-scale agile organizations to derive initial dimensions and characteristics. As a second and third iteration, we selected a conceptual-to-empirical (C2E) approach to ensure we considered all relevant dimensions. Based on literature reviews, we used literature investigating the characteristics of CoPs in general and related work studying CoPs in scaled agile settings. After satisfying all ending conditions in the third iteration, we concluded the first phase of our taxonomy development process. In the future, we plan to incorporate more iterations into our taxonomy.

3.2. Data collection

Interview study: For our first iteration, we chose an E2C cycle to develop a well-founded taxonomy for CoPs in scaled agile settings. We conducted semi-structured expert interviews (Fontana and Frey, 2000; Myers and Newman, 2007; Seaman, 1999) following the guidelines of Myers and Newman (2007). Thirty-nine experts from 18 organizations participated in our study (see Table 1). We only interviewed experts employed in scaled agile settings (Dingsøyr and Moe, 2014) in which CoPs exist and who are connected to at least one community as lead, member, or stakeholder (e.g., a manager sponsoring

CoPs). Also, we focused on selecting experts with various job and CoP roles from different industries to include different viewpoints (Myers and Newman, 2007). The main part of the interview questions was about CoPs within the experts' organizational setting. All interviews, except one, were recorded and transcribed. Besides the interviews, we included websites provided by the interviewees to enable data triangulation. Using a two-cycle approach, we coded and analyzed the collected data based on the guidelines by Miles et al. (2019) and Saldaña (2021). Inductive coding was the main method applied. Overall, we considered more than 100 CoPs.

Table 1. Interview partners

Organization	Interviewee (job role)	CoP role
SoftwareCo1	Manager	Lead, Stakeh.
InsureCo1	Enterprise Architect	Member
	CoP Lead	Lead
	Agile Coach, Enterprise Architect	Lead
SoftwareCo2	Agile Coach, Program Manager	Lead
	Software Architect	Member
	Security & Infrastr. Exp., Scrum Master	Lead, Member
	Developer, Scrum Master	Member
	Scrum Master	Lead
	Scrum Master	Lead
ConsultCo1	Manager	Lead
	Business Analyst	Lead
	Agile Coach, Scrum Master	Lead
ConsultProj	Consultant, Q&A Specialist	Member
CarCo1	Manager, Agile Coach, CoP Lead	Lead
CarCo2	Agile Coach	Lead, Member
ElectroCo	Agile Coach, Manager	Member
	Agile Coach	Lead
FoodCo	Agile Coach	Lead, Member
ConsultCo2	Agile Coach, Consultant, Prod. Owner	Lead
ConsultCo3	Consultant	Lead
HealthCo	Software Architect	Member
TeleCo1	Developer, Agile Coach	Lead
FashionCo	Enterprise Architect	Lead
TransportCo	Solution Architect	Member
	Solution Architect	Lead, Member
	System Architect	Lead, Member
	Enterprise Architect, Manager	Member
	Product Owner	Lead
RetailCo	Manager	Lead, Member
	Project Manager	Lead
TeleCo2	Manager	Stakeholder
	Organizational Developer	Stakeholder
	Enterprise Architect	Member
	Agile Master	Member
	Organizational Developer	Lead, Member
	Disciplinary Leader	Member
	Agile Master	Lead
InsureCo2	Enterprise Architect	Lead, Member

Literature review: After the initial iteration, we performed two rounds of C2E cycles. First, we studied two papers about CoPs not specific to the scaled agile context - one by Wenger et al. (2002) and a more recent paper presenting a literature review about CoP characteristics (Jassbi et al., 2015). In the last C2E cycle, we conducted a structured literature review (Kitchenham and Charters, 2007; Webster and Watson, 2002) to identify relevant studies about CoPs in scaled agile contexts. After an initial search, e.g., within Google Scholar and relevant publications (e.g., Uludağ et al.,

2022), we searched for papers in the databases IEEE Xplore, ACM Digital Library, Web of Science, Scopus, and AIS eLibrary to find as many related studies as possible (Kitchenham and Charters, 2007). For the search, we connected different sub-strings with boolean AND and OR connectors (Kitchenham and Charters, 2007). We included sub-strings covering *agile software development*, *large-scale development*, *scaling agile frameworks*, following the example of Uludağ et al. (2022), and *CoPs*. For the CoP search string part we added the phrases "round table", "guild","Community of Excellence" and "interest league." As all selected databases have individual syntax rules, we adjusted our search string accordingly. In total, we identified 1466 potentially relevant papers. After removing duplicates, we selected studies based on their metadata, abstract, and then full text. We used inclusion and exclusion criteria for an objective selection, e.g., we only included studies written in English. Since our literature review had a broader scope of CoPs in scaled agile settings in general, we narrowed the criteria to filter for studies relevant to this C2E cycle of the taxonomy development. Papers were only included if they presented CoP dimensions and characteristics. For efficiency, we already applied first selection criteria during the database search by using available filters, resulting in the 1466 papers mentioned. Overall, we identified five papers that fit our selection criteria and are relevant to our C2E cycle.

4. Results

4.1. Taxonomy

The resulting taxonomy comprises nine dimensions, of which three have sub-dimensions (see Figure 3).

Purpose: The first dimension of our taxonomy is the community purpose. This dimension contains a high amount of characteristics, as a CoP can be established for a variety of reasons and goals (Paasivaara and Lassenius, 2014; Tobisch et al., 2024). By consolidating the insights from our interview study and literature, we defined the following eight characteristics: *distribution of information*, *knowledge creation*, *knowledge sharing*, *support*, *definition of best practices or standards*, *improvement*, *creation of solutions*, and *innovation*. Even though most CoPs have a focus, this dimension is not mutually exclusive. We understand *distribution of information* as disseminating relevant information like news or changes to a specific target group (e.g., a particular role or people interested in a specific topic). *Knowledge creation* is about learning, building knowledge, or providing knowledge to a group of people who are, for example, new to a role or topic and need,

e.g., onboarding (Šmite, Moe, Levinta, and Floryan, 2019). CoPs with this purpose often rely on a more one-sided exchange (Šmite, Moe, Levinta, and Floryan, 2019), like training, rather than mutual knowledge sharing. *Knowledge sharing* CoPs exist to exchange experiences and learn from each other (Jassbi et al., 2015; Paasivaara and Lassenius, 2014; Šmite, Moe, Levinta, and Floryan, 2019; Šmite, Moe, Wigander, and Esser, 2019). *Support* includes communities that focus on mutual help for problems or concerns, allowing members to talk and share their thoughts (e.g., "everyday problems" (Jassbi et al., 2015)) with like-minded people in a safe environment. *Definition of best practices or standards*, we understand as the informal and formal standardization and the agreement on best practices to foster alignment across the organization (Jassbi et al., 2015; Šmite, Moe, Levinta, and Floryan, 2019; Šmite, Moe, Wigander, and Esser, 2019). *Improvement* is about people trying to maintain, improve, and evolve something (e.g., software) (Paasivaara and Lassenius, 2014; Šmite, Moe, Levinta, and Floryan, 2019; Šmite, Moe, Wigander, and Esser, 2019). *Creation of new solutions* means collaborating on artifacts that solve a common problem or support a specific objective. Finally, *innovation* includes working on trends or new technologies (e.g., AI) to foster organizational innovation (Jassbi et al., 2015). We found all characteristics of this dimension in our interview study, and most of them are also reflected in literature.

Organizational context: Another relevant dimension is the organizational context in which the CoP is situated. We divided this dimension into two sub-dimensions: the overall culture and mindset within the organization, including employees' mindset, and the organizational support. While the organizational support is explicitly reflected in literature (Jassbi et al., 2015; Tobisch et al., 2024; Wenger et al., 2002), the overall organizational attitude is not. However, as reported by Monte et al. (2022), our interview study showed that the organizational culture can influence CoPs and impact, e.g., their challenges. The characteristics of the overall organizational culture and mindset sub-dimension are: *hindering*, *neutral*, and *supporting*. By *hindering*, we mean a generally negative attitude towards openness, change, learning, and an agile working method. *Neutral* indicates that the organizational culture is neither supporting nor hindering. *Supporting* implies that people have an agile way of thinking and working, are open to change, and appreciate initiatives like CoPs. We defined the following characteristics for the organizational support sub-dimension: *no awareness but implicit approval*, *awareness and approval*, *active support*, *sponsorship*, and *dedicated budget*. Also, in this case, the characteristics are not necessarily mutually exclusive.

The first characteristic means management is unaware that a particular CoP exists. However, as it is common in scaled agile organizations (Tobisch et al., 2024), in all our interviews, such communities were still accepted as part of the organizational culture. *Awareness and approval* covers cases in which management knows about the existence of a CoP and either implicitly (part of the organizational culture) or explicitly approves its existence (Tobisch et al., 2024). *Active support* means management supports a community actively, e.g., by promoting it (Tobisch et al., 2024). *Sponsorship* involves management providing resources if needed (e.g., budget for guest speakers or events), and a *dedicated budget* means the CoP has its own funding, e.g., for a CoP lead position (Tobisch et al., 2024). This described sub-dimension reflects aspects highlighted by Wenger et al. (2002) and Jassbi et al. (2015) but goes further than only differentiating between high and low support.

Formation: The next relevant dimension for characterizing CoPs in scaled agile settings is their formation. We defined the following three characteristics for this dimension: *bottom-up initiation and set-up*, *top-down initiation and set-up by employees*, and *top-down initiation and set-up by management*. While literature (Jassbi et al., 2015; Paasivaara and Lassenius, 2014; Tobisch et al., 2024; Wenger et al., 2002) does not explicitly differentiate between the initiation and actual build-up, the interviews showed that also the process after the initiation of the CoP can be performed by different actors. *Bottom-up initiation and set-up* means the community starts without trigger or effort by the organization but is purely created by employees who see the need for it (Tobisch et al., 2024; Wenger et al., 2002). *Top-down initiation and set-up by employees* describes CoPs initiated by management (Jassbi et al., 2015; Tobisch et al., 2024; Wenger et al., 2002). However, individuals then take over to build up the community (e.g., invite potential members or create a strategy). In contrast, *top-down initiation and set-up by management* does not only mean management initiated the community but also actively built it up. Many organizations have top-down and bottom-up established CoPs (Tobisch et al., 2024), and the CoP driver can change over time (Paasivaara and Lassenius, 2014; Tobisch et al., 2024).

Life span: Based on literature (Jassbi et al., 2015; Wenger et al., 2002), we added the life span dimension to our taxonomy, describing how long a CoP is intended to exist. The characteristics of this dimension are: *long term* and *short term*. We understand *long term* as CoPs intended to exist long, having a rather strategic character (Jassbi et al., 2015). *Short term* means the community is intended for a short time frame, e.g., to solve an ad-hoc need within the organization (Jassbi et al., 2015).

Dimensions		Characteristics							
	Purpose	Distribution of information	Knowledge creation	Knowledge sharing	Support	Definition of best practices or standards	Improvement	Creation of solutions	Innovation
Organizational context	Overall organizational culture and mindset	Hindering			Neutral		Supporting		
	Organizational support	No awareness but implicit approval		Awareness and approval		Active support		Sponsorship	Dedicated budget
	Formation	Bottom-up initiation & set-up		Top-down initiation & set-up by employees			Top-down initiation & set-up by management		
	Life span	Long term				Short term			
Scope	Target group	Role-based				Topic-based			
	Location	Local			Single time zone			Multiple time zones	
	Organization	Single team of teams		Multiple teams of teams	Teams of teams' representatives	Whole development organization		Whole organization	Cross-organizational
	Size	< 10		> 10 < 50		> 50 < 100		> 100 < 1000	> 1000
Participation	Enrollment	Voluntary			Expected			Mandatory	
	Selection	Open				Closed			
Steering		Self-organizing		Reporting		Active steering		Management led	
Decision-making power		No decision-making power		Influence		Informal decision-making power		Formal decision-making power	
Maturity		Initiating		Growing		Established		Transforming	

Figure 3. Taxonomy for CoPs in large-scale agile software development

Scope: Moreover, we found the CoP scope to be a relevant dimension based on our interview study and literature. This dimension describes how broad the community is depending on different aspects. As for other dimensions, we split this into four sub-dimensions: the target group, the distribution of members, the organizational scope, and the CoP size. Those dimensions are also reflected in literature (e.g., Jassbi et al., 2015; Tobisch et al., 2024; Wenger et al., 2002), and, for example, SAFe differentiates between role- and topic-based CoPs (Scaled Agile Inc., 2023). The target group sub-dimensions characteristics are: *role-based* and *topic-based*. While *role-based* means a CoP is intended for people with a particular role (e.g., Scrum Masters (Scaled Agile Inc., 2023)), *topic-based* means for a specific topic, independent of any role (e.g., DevOps (Scaled Agile Inc., 2023)). Still, even if a CoP is intended for a specific role, it can be open to other interested people (Tobisch et al., 2024). The characteristics of the location sub-dimension are: *local*, *single time zone*, and *multiple time zones*. While *local* means CoP members are co-located at the same site (Wenger et al., 2002), *single time zone* means they are distributed on different sites but are not affected by time shifts. *Multiple time zones* covers CoPs with members in diverse parts of the world and, thus, different time zones. An increased member distribution can complicate, e.g., the CoP organization (Paasivaara and Lassenius, 2014; Wenger et al., 2002). The characteristics of the organizational scope sub-dimension are: *single team of teams*, *multiple teams of teams*, *teams of teams' representatives*, *whole development organization*, *whole organization*, and *cross-organizational*. We extended the generic categorizations of Wenger et al. (2002) and Jassbi et al. (2015), in line with Tobisch et al. (2024), with organizational structures typical for agile settings, such as teams of teams, e.g., ARTs or solution trains in SAFe (Scaled Agile Inc., 2024). Still, a CoP's scope depends on the structure of the respective (development) organization (Tobisch et al., 2024). While the first

characteristic means that all CoP members are from the same team of teams, the second one means members of different teams of teams participate (Tobisch et al., 2024). We understand *teams of teams' representatives* as communities that only have a single or a few members of each team of teams or sometimes people with some degree of leadership responsibility for a team of teams (e.g., System and Solution Architects (Scaled Agile Inc., 2024)). The characteristic *whole development organization* excludes that the community is restricted to any specific area of the IT organization, while the *whole organization* also includes non-IT areas (Tobisch et al., 2024). Finally, *cross-organizational* covers communities that span multiple organizations (Tobisch et al., 2024; Wenger et al., 2002). The characteristics of the final sub-dimension size (amount of members) are: <10, >10 <50, >50 <100, >100 <1000, >1000. While Jassbi et al. (2015) and Wenger et al. (2002) only differentiate between large and small CoPs regarding their size, we used the interview insights for more detail.

Participation: Another relevant dimension of CoPs in scaled agile contexts is participation, which describes how membership within a CoP is handled. Aligned with Jassbi et al. (2015), Tobisch et al. (2024), and our interview insights, we split this dimension into the two sub-dimensions of enrollment and member selection. The characteristics of the enrollment sub-dimension are: *voluntary*, *expected*, and *mandatory*. *Voluntary* means all existing and potential members can freely decide if they want to be part of the CoP (Jassbi et al., 2015; Tobisch et al., 2024; Uludağ et al., 2019). *Expected* means people, e.g., with a certain role, are expected to join and participate in the community or that being a member and attending meetings is recommended (Tobisch et al., 2024). *Mandatory* participation means that being a part of the community is not optional but required (Jassbi et al., 2015; Tobisch et al., 2024; Uludağ et al., 2019). Despite being controversial, mandatory participation can also be beneficial, e.g., for ensuring high representativeness (Šmite, Moe, Wigander, and

Esser, 2019). Those characteristics are not mutually exclusive, as we also found role-based CoPs in our interview study, which were mandatory for people with a specific role but voluntary for others without that role. Likewise, Jassbi et al. (2015) differentiate "mixed" enrollment. The member selection sub-dimension characteristics are: *open* and *closed*. *Open* CoPs allow every person (Jassbi et al., 2015; Šmite, Moe, Wigander, and Esser, 2019; Tobisch et al., 2024), independent, e.g., of their role, to join without any restrictions. Openness is often seen as a success factor (Paasivaara and Lassenius, 2014; Wenger et al., 2002). *Closed* CoPs have restricted accessibility (Jassbi et al., 2015; Tobisch et al., 2024).

Steering: Besides the already presented dimensions, we included the degree of steering regarding the community as a dimension in our taxonomy. According to Wenger et al. (2002), this steering can be connected to the level of organizational support the community is retrieving. The characteristics of this dimension are: *self-organizing*, *reporting*, *active steering*, and *management led*. For this dimension, especially the characteristics of reporting and active steering are not necessarily exclusive. *Self-organizing* means that management is not involved in the community in any way, but the CoP can decide and act freely, e.g., on how it organizes itself. *Reporting* describes communities that might still be able to decide freely on their way of working without prescription by management but regularly report their current state and progress to management. *Active steering* reflects active interference by management, e.g., prescribing topics or monitoring the community (Tobisch et al., 2024). Finally, *management led* means that the CoP is led by a management person who actively decides which direction the CoP is pursuing (Tobisch et al., 2024).

Decision-making power: The next relevant dimension is the CoP's degree of decision-making power. This aspect of CoPs is often found in scaled agile settings, seen as a success factor (Paasivaara and Lassenius, 2014; Šmite, Moe, Levinta, and Floryan, 2019; Šmite, Moe, Wigander, and Esser, 2019; Tobisch et al., 2024), and was very present in our interview study. The characteristics of this dimension are: *no decision-making power*, *influence*, *informal decision-making power*, and *formal decision-making power*. *No decision-making power* means the CoP cannot do or influence any decisions (Tobisch et al., 2024) but often mainly has the purpose of, e.g., knowledge sharing. *Influence* describes communities that can influence certain decisions, e.g., with their collective opinion or a recommendation (Šmite, Moe, Wigander, and Esser, 2019; Tobisch et al., 2024). *Informal decision-making power* includes CoPs that make decisions that their members and affected individuals respect (e.g., defining best practices) but lack an official mandate by the organization. Lastly, *formal decision-making power* means the CoP makes formal decisions, e.g., by voting, that are officially legitimized by the organization (Uludağ et al., 2019).

Maturity: Finally, in line with Wenger et al. (2002), we included CoPs' maturity level in our taxonomy, reflecting the various states of their lifecycle. This dimension is one of the few we only added after reviewing related literature. Still, we adjusted the characteristics to the maturity levels we could derive from the CoPs found in our interview study. The characteristics of the maturity dimension are: *initiating*, *growing*, *established*, and *transforming*. *Initiating* refers to the first part of the CoP lifecycle in which the CoP idea is created, e.g., starting from an informal group or with a dedicated plan (Wenger et al., 2002). This phase can involve defining a goal and the community getting prepared and set up. *Growing* stands for the CoP phase that follows the initiation. Members start joining and participating in the community. The CoP finds its direction and suitable way of working, matures, and often grows in size (Wenger et al., 2002). *Established* describes the period after the growth phase. The CoP is mature, has proven its value, and has low and high activity stages (Wenger et al., 2002). *Transforming* is the last phase in a CoP's lifecycle (Wenger et al., 2002). The CoP either ends or must change based on the needs and interests of its members and the organization. Each maturity level has specific challenges (Wenger et al., 2002).

4.2. Application of the taxonomy

Our first taxonomy development iteration was based on an expert interview study on CoPs in scaled agile settings. We identified over 100 CoPs for themes specific and not specific to agility (e.g., Scrum Masters vs. security). Hereafter, we will illustrate the applicability of our taxonomy with two example CoPs of this study. Despite agility being the most frequent theme, most CoPs dealt with non-agile-specific themes, common for agile settings (e.g., Tobisch et al., 2024). Therefore, we selected the examples with a focus on highlighting the potential variety in dimensions and characteristics.

Data Science & AI CoP: One expert we interviewed, working in a rather small agile software development company with two agile development teams, gave us insights into a CoP for data science and AI. This community was established to create knowledge regarding the technology and to work on how it could be integrated into the company's product(s). The organization's culture and mindset can be described as neutral, with positive and negative attitudes towards,

e.g., agile, learning, and change. Our interviewee, as a manager, is aware of this CoP, approves the members spending time on it, and also wants to support it by finding more members. The CoP was initiated and created bottom-up as an informal, small group of people discussing this topic. We assume the CoP has a short term time frame until sufficient knowledge is built and enough ideas are collected. The CoP does not target any particular role but is topic-centric. The less than ten members are distributed in the same time zone, often also meeting hybrid. Due to the organization's small size, the CoP spans the whole (development) organization. Participation is voluntary and not restricted. At the time of our interview, the CoP was self-organizing. Despite not having any decision-making power, the community's findings can influence how data science and AI will be used in the organization. During our interview, the CoP was in its starting phase, only existing for a few weeks.

Architecture CoP: We interviewed several experts from a large insurance company who shared information on a Architecture CoP. This CoP primarily aims to share knowledge and define architecture standards as it replaced previously existing architecture boards. The organizational culture is very supportive of an agile way of working. The organization is not only actively supporting the CoP (e.g., promotion) but also providing a budget as part of its scaling agile approach. The CoP was initiated top-down by management and built up by an employee still leading it. Due to its purpose, the CoP has a long term orientation. The CoP is role-based as it addresses different architecture roles but has several topic-based sub-communities focusing on topics like data governance and architecture. The more than 100 members are distributed within the company's German part, covering the whole development organization (not the whole corporation's IT). Participation is mandatory for architecture roles but voluntary for others and the sub-CoPs. Also, the CoP is open. The CoP reports to management and is actively steered by it (e.g., its topics). Due to its purpose, the CoP has a formal decision-making power, making community-based decisions. At the time of our interview, the CoP had existed for around two to three years and was well-established.

5. Discussion

Our taxonomy describes nine dimensions that should be considered when establishing and cultivating CoPs in scaled agile contexts (see Figure 3).

5.1. Theoretical contributions

Our study contributes to the descriptive knowledge of CoPs in scaled agile settings, extending and tailoring the generic concepts of Jassbi et al. (2015) and Wenger et al. (2002) to a scaled agile organizational context. Moreover, our taxonomy builds on and extends the insights of studies in single large-scale agile organizations (e.g., Paasivaara and Lassenius, 2014), combining literature findings with empirical data. We also provide a more structured and detailed few on the dimensions and characteristics relevant to establishing and cultivating CoPs in large-scale agile software development than previous studies (e.g., Tobisch et al., 2024). In addition, even though limited, our study gives practical insights into two CoPs in different organizational contexts.

5.2. Practical contributions

A first practical contribution is the taxonomy's value for practitioners (e.g., organizations or individuals) who plan to initiate a CoP within their large-scale agile environment. Our taxonomy can guide the establishment by providing an overview of the aspects that must be considered and decided on. We collected questions that our taxonomy can support in Table 2. Some dimensions, like formation and maturity, are less relevant for this use case. Also, the taxonomy provides an overview of the dimensions characterizing how a CoP is established and cultivated. Thus, this taxonomy can help provide context-specific support for adopting CoPs in scaled agile settings, as it allows putting CoPs into context and providing guidance for CoPs with specific characteristics building on identified patterns ("best practices"). Finally, applying our taxonomy to two examples offers initial insights into the variety of characteristics of CoPs in different contexts. Practitioners should be aware of this variety and carefully consider their CoP set-up.

5.3. Limitations

There exist several limitations to our study. First, despite following the taxonomy development process by Nickerson et al. (2013), deriving dimensions and characteristics is based on subjectivity. Second, agile environments are constantly evolving, and various organizational contexts exist. Even though we included many empirical cases through our interviews and incorporated literature, our taxonomy is not guaranteed to cover all possible dimensions and characteristics. Also, as only one of our C2E cycles relies on a structured literature review, there is the risk that we did not include all relevant studies. In addition, considering the taxonomy development method by Kundisch et al. (2022), extending the method by Nickerson et al. (2013) with an evaluation phase, we lack feedback on our taxonomy's validity, completeness, and usefulness. Finally, there are several threats to the interview study's validity (Runeson

Table 2. Taxonomy as guidance for initiating CoPs in scaled agile settings

Dimension	Management/Organization	Individuals
Purpose	*What is the purpose of the CoP?*	
Organizational context	*Is the organizational culture and mindset supporting the establishment of the CoP?*	
	Which level of organizational support should be provided?	*Which level of organizational support is needed and can be expected?*
Formation	*Who should set-up the CoP?*	-
Life span	*Is the CoP planned to exist for the long or short term?*	
Scope	*What scope should the CoP have considering the target group, geographical and organizational scope, and size?*	
Participation	*How should the participation be managed in regard to member selection and enrollment?*	
Steering	*To which degree should the CoP be steered?*	*Which degree of steering is desired and can be expected?*
Decision-making p.	*Which level of decision-making power should the CoP have?*	*Which level of decision-making power is desired and can be expected?*
Maturity	*How can we increase the CoP's maturity?*	

and Höst, 2009) that we tried to address. For example, to increase reliability, we followed guidelines during the data collection and analysis (e.g., Miles et al., 2019).

5.4. Future research

The study's limitations present starting points for future research. As mentioned, we plan to conduct more iterations to develop and improve the taxonomy. Next to a structured literature review on taxonomies of CoPs in other contexts (e.g., scientific CoPs) (C2E) and case study data (E2C), we want to build on studies identified in our literature review that investigate and describe different CoPs without conceptualizing any dimension or characteristics (E2C). After conducting the additional cycles, we plan to evaluate the taxonomy according to Kundisch et al. (2022), e.g., through interviews with practitioners. Also, while analyzing the empirical data and applying the taxonomy to the different CoPs we found in our interview study, we discovered patterns (e.g., recurring combinations of specific characteristics) that we want to investigate further. Moreover, based on the taxonomy, we plan to provide context-dependent guidance for establishing and cultivating CoPs in scaled agile settings, building on discovered patterns (i.e., "best practices") for CoPs with specific characteristics.

6. Conclusion

Our paper contributes to a comprehensive taxonomy for CoPs in large-scale agile software development, providing theoretical and practical implications. This taxonomy structures CoPs based on the dimensions that must be considered in their establishment and cultivation. By structuring these dimensions, we not only enhance the understanding of CoPs but also provide practitioners with critical considerations for establishing and nurturing CoPs in scaled agile settings. However, future research is needed to develop and extend this taxonomy. By building on the taxonomy to offer detailed insights (e.g., patterns) and context-specific guidance, practitioners can be empowered to fully leverage CoPs' potential in supporting the successful scaling of agile practices.

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