Some reasons why actual cross-fertilization in cross-functional agile teams is difficult

Helena Barke
Freie Universität Berlin
Berlin
h.barke@fu-berlin.de

Lutz Prechelt
Freie Universität Berlin
Berlin
prechelt@inf.fu-berlin.de

ABSTRACT

Background: Agile teams are supposed to be cross-functional in order to be complete (so they can work without external help). Cross-functionality is also supposed to produce cross-fertilization: Better ideas and solutions, problems prevented or detected earlier, etc. *Question:* What is motivating or demotivating team members to work in a cross-functional manner? *Method:* We conceptualize observations from five agile teams (work observations, interviews, group discussion) and from interviews with five agile consultants/coaches by applying Grounded Theory Methodology. *Results:* The inclination to interact cross functionally is moderated by at least six factors such as perceived inefficiency, a sense of responsibility for one's own functional domain, or the difficulty to find a level of detail that is suitable for the collaboration. *Conclusion:* Cross-fertilization is harder to get than one might expect and teams need to develop good judgment to succeed at it.

CCS CONCEPTS

• **Software and its engineering → Agile software development**; *Programming teams*;

KEYWORDS

Cross-functional, Scrum, Self-organized Teams

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1 INTRODUCTION

Agile software development is now a mainstream software development model [21]. The most commonly used agile framework is Scrum [14]. According to the Scrum Guide, Scrum Teams should be *cross-functional* teams [24]. But what does that mean?

The Scrum Guide merely states "Cross-functional teams have all competencies needed to accomplish the work without depending on others not part of the team." In addition, the task of the Scrum Master contains "Coaching the Development Team in self-organization and cross-functionality" [24]. Potential difficulties with becoming or being cross-functional are not discussed.

Moe et al. [19] point out that there is a gap between the theory of the Scrum Guide and working as a Scrum Team in practice. Hoda contributes to reducing this gap with her grounded theory of self-organizing teams [9, 10]. She describes *balancing acts* in which self-organized agile teams have to find a balance between cross-functionality and specialization or between steady learning and iteration pressure. She states *'Most Agile teams we studied were highly cohesive and cooperative, helping each other learn new skills across different technical areas.'* [10]. Cross-functionality is expected to be positive, but of course there are obstacles that make it difficult to get there. They are the topic of the present work.

There is some research specifically about cross-functional teams from various perspectives: There is extensive research about innovation, new product development and success factors [11, 18, 20, 22], and team-inherent aspects like team performance [12, 25], conflicts [17] and communication [3], and also the perspective of non-software-engineers [16]. What is yet missing is the *individual* perspective of the team members which is the one we will use here:

> Research question: What is motivating or demotivating team members to work in a cross-functional manner?

Being cross-functional has two aspects:

(1) A cross-functional team ought to be *complete*, that is, able to solve all their problems without external help, by having all required expertise within the team at any time [2]. This helps make steady progress.
(2) A cross-functional team can also *supposedly* work *better* than a non-cross-functional one. Scrum inventors Takeuchi and Nonaka [8] write: *'While selecting a diverse team is crucial, it isn't until the members start to interact that cross-fertilization actually takes place'*. By cross-fertilization they mean all the positive effects from the knowledge availability and knowledge transfer when people with different specializations collaborate. By interacting closely, the team should be able to anticipate problems better (and hence avoid rework) and find better and more innovative solutions (and hence produce more value). If enough cross-fertilization occurs, it will be a major source of advantages for agile processes.

We are concerned with the second of these aspects here and will use a perspective centered on the individual. Therefore, aspects such as team performance, innovativeness and so on will occur in our work, but only from a subjective point of view: as perceptions; we make almost no attempt to determine the underlying facts.

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Our contribution is to explain how and why cross-fertilization is difficult by applying Grounded Theory Methodology to observational and interview data from several agile team contexts. Our results may help team members to reflect on their own cross-fertilization work style (or lack thereof) and may give Scrum Masters and Agile Coaches fresh ideas how to add value.

The results are preliminary; we do not claim to formulate a complete theory and only explain a (likely incomplete) set of mechanisms at work in this context, so far mostly revolving around team member motivation.

We will proceed to describe the nature and origin of our data and the research method applied (Section 2) and then explain and illustrate the mechanisms we found (Section 3) and shortly discuss limitations and validation (Section 4). We formulate conclusions in Section 5.

2 RESEARCH CONTEXT AND METHOD

This work uses elements of Grounded Theory Methodology (GTM), which by now is well-established in software engineering research [1, 23] and appears particularly well-suited to study agile approaches [13]. We share the epistemological position of Charmaz [4], which is that a Grounded Theory does not state some canonical, objective truth, but rather reflects an objective reality in a manner that is truthful, but shaped by the particular perspective of the researcher (constructivist GTM).

2.1 Background of the Scrum Teams

Most of the data comes from five software development teams, some other from interviews with consultants. We characterize the teams (which we will call t1 to t5) here.

All team stated to work with Scrum. Besides working with Scrum (which was the only property they all had in common) they represent a wide spectrum as follows:

- t1 came from a company of 90 employees developing a business management software and had been working with Scrum since 6 years.
- t2 came from a waterfall background, starting agile about one year ago. The team was distributed over 3 countries in a company of about 1,500 employees developing a hardware planning tool for mainly internal use.
- t3 was in a big public institution (15,000 employees, 15 Scrum Teams developing a large information system with complex business logic) with external team members from a service company and a long waterfall background. It had been agile since 2 years.
- t4 was in a small start-up of less than 25 employees developing a web portal, working agile since 4 years. They had started with a single Scrum Team and split into 2 Scrum Teams 1.5 years ago.
- t5 (in a company of 150 people) worked on an e-commerce web portal for a much bigger parent company, specifically on importing data from their suppliers' external databases. They had started with Scrum, switched to Kanban, then switched back to Scrum.

Our quotes will be tied to individual team members, which we designate like this: t4dev2, which means team t4, second person in a developer role. As roles, we will use dev (developer), m (marketing person), sm (scrum master), test (tester).

2.2 Data collection

In total, the present research is based on 14 qualitative interviews, one group discussion, and more than 100 pages of observation protocols. All data collection was done by the first author.

Interviews: The interviews were face-to-face, hour-long, semi-structured interviews, focused on individual action and perceptions.[1] The interview questions varied over time in the spirit of *theoretical sampling*.

Observations: In three teams (t2, t3, and t5) Helena Barke observed at least two successive sprint changes. The sprint changes included Retrospective, Review, and Planning. Where possible, she also observed Refinements and Daily Scrums. The written protocols of these events contain as much verbatim language as possible. Additionally, two or more team members were interviewed to get different insider perspectives on the teams. The interviews were recorded and transcribed.

Feedback: After completing data collection in these teams and initial analysis of the status quo, Helena Barke shared her preliminary results with the respective teams and asked for feedback. Notes from the feedback sessions were fed back into the research process to enrich and validate the identified concepts. The longest research collaboration with one team (t2) lasted 11 months.

Group discussion: In one team (t4) she observed two Refinements, one Planning and one Retrospective and then held a group discussion as follows. She asked the team the following questions: What is the value of cross-functionality

(1) …for your team?
(2) …for you?
(3) …for the product?

Each team member answered the questions secretly on sticky notes and then all presented their answers. Helena Barke contradicted their answers with concrete examples from her observations, and a discussion between the team members about their personal experience, value, and limitations of cross-functional work evolved. The discussion took about one hour and was recorded, transcribed, and coded.

Expert interviews (outside teams): Additionally, we use data from five expert interviews with agile Coaches, Consultants, and Scrum Masters outside the context of any particular team. We asked them to report on concrete teams and give examples of team work and situations. As Consultants, they were able to provide examples from a range of companies of different sizes, domains, and agile backgrounds.

2.3 Data analysis

In this section, we explain some aspects of our implementation of the GTM coding process. It uses Charmaz' GTM [4] as the process guideline and MAXQDA[2] as our software tool.

[1] It was challenging to conduct the interview such that team members would really think and answer from their *individual perspective*. They had a strong tendency to constantly switch to a team perspective.
[2] MAXQDA: Qualitative Data Analysis Software: https://www.maxqda.com/

The data was *initially coded* by the first author as follows: She started with detailed coding of relevant word-by-word sections from the interviews using Charmaz' questions and advices [4, p.116ff] which are based on Glaser's open coding. The codes focused more on *actions* instead of *assigning types to people*. Subsequently, Charmaz's comparative methods were used, which are based on Glaser and Strauss' *constant comparison* [7]. Comparing and coding incident by incident helped to enrich and differentiate the concepts and led to higher abstractions.

After some amount of *focused coding*, preliminary results (in particular regarding cross-functionality) were presented and discussed within our research group. The results of this discussion were used for further *focused coding* to enhance its *theoretical coding*, which led to the category Cross-Functionality presented in this article. Despite Charmaz' skepticism as to the usefulness of using pre-formed models during the coding process [4], we used parts of Strauss and Corbin's paradigmatic model [5] insofar as that appeared to enhance the results and was fully adequate for the given data. (We also use the paradigmatic model to give our presentation of the results some additional structure.)

During the whole process memos were written. This helped to crystallize and enrich the categories and gain new insights. It also documented the process.

When we started writing the present article, both authors participated in further coding as the narrative unfolded, which led to the adjustment (and sometimes renaming) of some concepts and the discovery of several others.

2.4 Notation

To improve readability and clarity, we will use the following markup.
Names of concepts will be shown like this: Concept Name.
Verbal quotes will be shown like this: *"I said this!"* (`speaker, source`).
Material from observation notes will be shown like this: *This is a statement from the notes.* (`source`).

The appearance of a concept name indicates a statement is grounded in the data and a quote or note is often (but not always) provided to make this more concrete and palpable. Other statements will often represent explanatory interpretation by us. The quotes were originally in German and we have turned their grammar into written language during translation.

As mentioned above although we used Charmazian GTM for the analysis, we use terms from Strauss/Corbin GTM [5] in the reporting, because their paradigm model (or "coding paradigm") fits well with the nature of our results.[3] An instance of the paradigm model focuses on one concept called the *Phenomenon* and describes its relationships to various other concepts: The *Context* is where the Phenomenon is situated; *Action/Interaction* describes how the people act with respect to the Phenomenon; *Intervening Conditions* are what shapes a particular instance of the Phenomenon and facilitates or constrains Actions and Interactions. *Consequences* are what arises due to the Phenomenon beyond the Actions and Interactions.

[3] In place of the paradigm model, Glaserian GTM, which does not have axial coding, offers a multitude of "coding families" [6], one of which is very similar to the paradigm model. For our purposes here, the paradigm model is adequate.

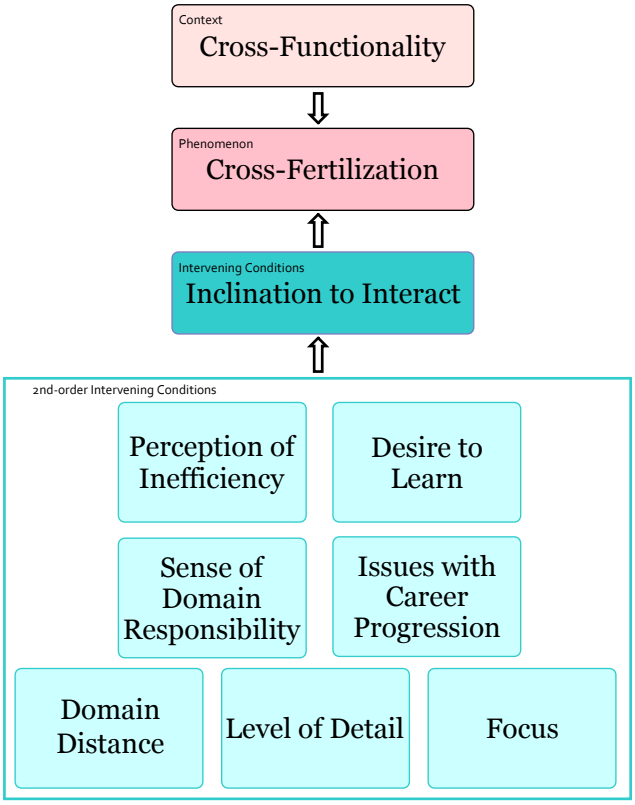

Figure 1: Cross-Fertilization Process

3 RESULTS

We report on an extended paradigm model instance here. As shown in Figure 1, it has Cross-Functionality as the context, which gives rise to the phenomenon of Cross-Fertilization, which is shaped by the intervening condition Inclination to Interact. The bulk of the reporting will be about the seven 2nd-order intervening conditions in the rectangle at the bottom of the figure and a number of cross-secting concepts that occur in the discussion of several of them.

3.1 Cross-Functionality

The context Cross-Functional is present as soon as team members have different Specializations, which can be different Functional Roles [10] (such as tester and developer or hardware people and software people) or different Technical Areas of Expertise [10] (such as different programming languages or parts of the application). Developers' specialization provides them with a comfort zone: an area with which they feel familiar, in which they are confident, in which to work they like the most, and which some of them like to call their Domain.

In principle, Specialization and Domain are the same thing, but the word domain better hints at the comfort zone effect, which is why we will often refer to it as Domain when we mean the team member's self-view and as Specialization when we mean an outside view of others.

3.2 Cross-Fertilization

Cross-Functionality can give rise to Cross-Fertilization. Of the two aspects of Cross-Fertilization mentioned in the introduction, Working Steadier[4] (completeness) and Working Better, the former is so familiar to agile teams that it hardly cropped up in our field research.

The latter again has two aspects: Knowledge Transfer and Added Value.

For the first of these, one team member formulated the purpose and benefit of Cross-Functionality like this: *"Knowledge transfer. I learn many new things that I might not have learned alone – if I wouldn't have left my comfort zone."* (`t4m1, group discussion`). That one team member knows more may have no immediate benefits for the team, but obviously has a latent benefit in the future whenever that knowledge becomes useful to make a better engineering decision or perform a work step with it.

Nevertheless, immediate benefits also arise from cross-functionality from time to time. They are what we (somewhat vaguely) call Added Value.[5] Example: *"In a Scrum Team (for a hardware product) that included a design engineer and a production engineer, when they worked together they recognized how several steps in the manufacturing process could be saved, if they rearranged several components in the physical design of the product. The change was big, but the savings were much bigger still; it was early enough in the process and saved time and money. None of them alone could have devised this improved approach."* (`consultant F, interview, paraphrased`)

3.3 Good judgment and Inclination to Interact

Cross-Fertilization can only happen when team members interact. How much they do so depends a lot on themselves: As there is no manager ordering them to interact,[6] they need to develop a motivation to do so (individually and at the team level). We call this motivation the Inclination to Interact (and focus mostly on the individual component). It modulates the amount of possible Cross-Fertilization, i.e. it is an Intervening Condition.

Collaboration has both benefits and costs, so there can be too much interaction as well as too little. This is what Hoda's term of "balancing act" (between cross-functionality and specialization) refers to [9]. Good judgment is required, which explains (as we will see below) why teams continually struggle to decide whether interaction is useful enough or not. The remainder of our results will discuss a number of 2nd-order Intervening Conditions that modulate (mostly: limit) the Inclination to Interact.

As we will see below, the forces we have uncovered all tend to increase or decrease interaction rather than only impacting its shape or content. Insofar as that means the actual level of interaction will be lower or higher than useful (which neither we nor the teams can reliably know), these forces can be considered impediments to an ideal process in the Scrum sense.

[4]This concept is grounded in the literature (in Glaserian fashion), not in our own field observations.

[5]Note that the important quantitative questions how valuable such an event will be and how frequent they are lie outside our research question.

[6]Even though there were managers who built the cross-functional teams with the idea that they should interact

3.4 Perception of Inefficiency

Although the members in the teams we have observed understand the idea of Added Value, they were aware of possible negative effects from cross-functional interaction as well. Fear of such negative effects can reduce the Inclination to Interact. One example is the Perception of Inefficiency: I expect that I will be less efficient when I work in a different Domain than my own, simply because I am less skilled in the other Specialization. This perception may be correct or not, but will tend to decrease interaction in either case.

One of our expert interviewees described such a case like this: *"The team perceived work to be inefficient, because not every specialization was fully utilized at every time. They were skeptical because for somebody who wants to write software around the clock it felt unsatisfying if they would* not *write software on, say, three days a week – simply because there was nothing to be done at that time."* (`consultant F, interview, paraphrased`)

3.5 Cross-secting auxiliary concepts: Self-oriented, Team-oriented

Ideally, team members and management would accept that during incremental work in a cross-functional team, not every role will have full utilization at all times and would view this as a cross-fertilization opportunity: a Team-oriented perspective.

But in practice, the personal preference of rather working in their own Domain took precedence in their view of what was a good process: a Self-oriented perspective.

3.6 Desire to Learn

Personal preference can also work in the other direction and increase the Inclination to Interact. For example, we found a tester who wants to become a developer: *"When I applied here, I thought my application would be more convincing for a tester role, so I got that. Now I've been here for six years and at some point I thought 'I somehow miss developing'. And then eventually taking testing courses was maxed out. Back when we still did waterfall, when I applied for a Java training, it was rejected. But now that we do Scrum, it is the only way I can become more cross-functional, so they cannot say no."* (`t3test1, interview, paraphrased`)

Such a Desire to Learn is Team-oriented and Self-oriented at the same time.

3.7 Sense of Domain Responsibility

A second factor besides the Perception of Inefficiency that may reduce the team members' Inclination to Interact can be a sense of responsibility to keep both the work and their personal knowledge in their own Domain in proper shape. Some members feel that cross-functional collaboration may result in a situation where their own work is no longer done as well as they expect of themselves: *"It happens very fast that you have no more expertise at all, in any area."* (`t2dev1, interview`)

This responsibility appears to have a Team-oriented as well as a strong Self-oriented component.

3.8 Issues with Career Progression

Cross-functional work can also be perceived to slow down one's personal development in a (conventional, non-agile) career sense. Such Issues with Career Progression will also decrease the Inclination to Interact as in the following frustrated explanation: *"The problem is: I cannot grow. For example, when you explain your job to a relative: I am a member of a team. Great, what do you need to do to become team lead? There is no team lead. So you cannot proceed in your career?"* (t4m2, group discussion)

The former Scrum Master of t4 explained: *"[Name of a team member] leaves the company in a non-voluntary manner. He is a good and committed guy, but he is now in a certain age and wants to get a leadership position and more money. We tried to explain that it does not work that way in an agile company with cross-functional teams. Now he is leaving."* (t4sm2, interview, paraphrased)

3.9 Domain Distance

A fairly obvious and more technical (rather than emotional) issue that modulates the Inclination to Interact is Domain Distance: How far is the specialization with which I might interact away from my own area of expertise? It depends on the closeness of content in cross-functional cooperation, whether the collaboration is perceived as productive and/or whether positive effects indeed arise.

The farther the Specializations are apart, the more difficult the cooperation tends to become (see also Section 3.10) and the lower the Inclination to Interact tends to be. But the possible Added Value also increases. And indeed, if such positive effects do arise and team members recognize benefits (in particular for their own Domain), their Inclination to Interact increases.

A negative example: *A developer participated in the creation of a newsletter by the marketing specialists and in particular selected images to be used in the newsletter. He saw this as inefficient and demotivating.* (t4dev1, group discussion and work observation protocol)

As a positive example, the cooperation of UX and Developers was experienced as successful as the developers recognized the effect for their own Domain: *"We had a very smart UX designer and a front-end developer with UX experience. [...] They built some wireframes and that was fun for the other developers as well. Everybody was deeply involved conceptually: It was not that they twiddled their thumbs while waiting for the design to be done; they had to think very carefully about what that would mean in the end, in terms of architecture and services and so on for their own domain."* (consultant F, interview).

3.10 Level of Detail

When collaborating with a far-away Specialization the Inclination to Interact will be higher if the collaboration partner offers information at a suitable Level of Detail. In particular, when the level of detail becomes too high, team members from a different Specialization easily become overwhelmed: *"So very small parts! This made the process lengthy and made it impossible for me to contribute."* (t4dev1, group discussion)

Or like this: *"I need it step-by-step and kept simple. But the discussion always goes into much detail [...] and becomes very complicated."* (t3dev1, retrospective 2)

On the other hand, for a nearby Specialization or when there is a strong-enough Desire to Learn, the suitable Level of Detail may be quite high, like in this case where a tester is willing to delve into the code: *"We go into a lot of detail about certain design strands or the architecture or the code of the Java implementation. All the techniques and stuff.*
Now that I'm close enough, this gives me a lot more understanding than it formerly did. My thinking moves more towards white box thinking, no longer so black-box-ish, because I know more.
And to put it in the right place within the testing pyramid, I need this detailed knowledge." (t3test1, interview, paraphrased)

But choosing the level of detail can be difficult: *Team t2 discussed several times the idea to stimulate knowledge transfer between the specializations and to cooperate more closely, e.g. by brief presentations from the respective specialist, pair programming, or mutual review.*
But the dispute about the suitable Level of Detail could never be settled: Some members found that when the Level of Detail is too low, sufficient and therefore helpful understanding is not possible. Yet with a high level of detail other non-specialists lack enough interest; they feel they lack sufficient time and too little benefit is recognizable. The team suspected their Domain Distances were too high. (t2, Retrospective 3)

3.11 Focus

Even when the Perception of Inefficiency is low or absent, the Sense of Domain Responsibility is not getting in the way, and collaboration opportunities can be found with reasonable Domain Distance and a suitable Level of Detail known, some team members are wary of too much cross-functional collaboration, because they fear the team might lose its Focus: *"[A danger is] defocusing, because you just do a thousand things, talking to each other, but nothing gets completed."* (t4m1, group discussion)

We have also seen too much collaboration to lead to conflicts about prioritization between the team members of different Specializations, especially if they do have a high Sense of Responsibility for their Domain.

4 LIMITATIONS, VALIDATION

Except for actual mistakes when applying the GTM, the results of a Grounded Theory study will not be *wrong*, because they are grounded directly in data. But the concepts chosen are shaped by the particular perspective of the researchers and this perspective can mislead. In particular, the relevance of the factors reported above is not self-evident: It could be that some of them are rare or their impact very small. Also, our data is likely not broad enough to cover all relevant factors of the Inclination to Interact phenomenon.

We have performed a preliminary validation of relevance and completeness via a feedback discussion with a CEO of an agile consultant firm, a person with long agile coaching experience. From her point of view, our conceptual model touches all relevant aspects of cross-functional work and is suitable for understanding a team's specific situation with respect to cross-fertilization.

5 CONCLUSIONS

As with so many aspects of agile methods, what looks like a natural and almost obvious idea in theory, namely to achieve Cross-Fertilization through cross-functional collaboration, is quite difficult to realize in practice. Not only can it be difficult to achieve useful cross-fertilization, it is also difficult to judge whether a particular collaboration *is* (or is going to be) useful. The latter effect will never go away, because the situations are unique and quantitative evaluation is nearly always impossible. So be prepared to find that Inclination to Interact is unique as well and varies by team member (in particular their preference for a Team-oriented or a Self-oriented perspective) and short-term situation. Some degree of understandability of and influence on the Inclination to Interact is provided by the following factors:

- Perception of Inefficiency: When team members work outside their own specialization, they feel less skilled and hence perceive the work mode to be inefficient.
  This reduces the Inclination to Interact.
- Desire to Learn: Whether cross-functional work is perceived as attractive depends on a team member's desire to learn material outside their own specialization.
  This can increase or reduce the Inclination to Interact.
- Sense of Domain Responsibility: When occupied with cross-functional work, one can less well maintain or extend one's skills in one's main domain of knowledge.
  This may reduce the Inclination to Interact.
- Issues with Career Progression: Some team members may perceive their professional development to be hampered by cross-functional collaboration, which will then reduce their Inclination to Interact.
- Domain Distance: The farther the specialization of a collaboration partner is away from my own, the larger (at least potentially) the cross-fertilization opportunity, but the higher also the barrier to achieve a meaningful and helpful collaboration.
  Difficulty in establishing collaborations with suitable domain distances can reduce the Inclination to Interact.
- Level of Detail: One reason why helpful collaborations are difficult over wide domain distance is the difficulty of finding a suitable balance between too much detail (for the foreign collaborator) and too little (for the 'home' collaborator).
  This can reduce the Inclination to Interact.
- Focus: Finally, cross-functional collaboration might detract from important aspects of individual specializations enough for the team to lose its focus.
  Fear of this happening may reduce the Inclination to Interact.

As a result, teams will likely struggle with fulfilling the promise of cross-fertilization – or else will neglect its chances and get too little of it.

As a next step, the results will be presented to practitioners for further validation: Agile Consultants, Coaches and Scrum Masters. After that, we will try to apply the concepts with Scrum Teams in their daily work, perhaps in combination with the Cynefin framework [15] to help the teams cope with the high uncertainty in the decision-making involved.

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