Team Performance in Agile Development Teams: Findings from 18 Focus Groups

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Abstract. How to make teams perform well is increasingly important in software development, as agile development methods prescribe development in small teams. Team performance has been studied in a number of research fields, and there are many models of what enables team performance. A central question then is how relevant these models are for agile development teams. This article investigates the following research question: What factors do agile software practitioners perceive to influence effective teamwork, through a focus group study with 92 participants in 18 groups. The main findings are that what agile practitioners perceive foster and hinder team performance seems to comply well with what is stated in an existing research-based model. However, agile practitioners seem to place insufficient focus on backup behaviour. Agile practitioners place much emphasis on physical and technical infrastructure of the development team as enablers of team performance.

Keywords: team performance, agile software development, software engineering, software process improvement, focus group.

1 Introduction

Agile software development methods have led to a number of changes in the way software is developed [1]. One of the principles behind the agile manifesto states that "the best architectures, requirements, and designs emerge from self-organizing teams". While there are reports of major improvement with agile development methods over traditional development methods [2], team performance is still a challenge. Stray et al. [3] summarize the following challenges to teamwork: Team members solve the wrong tasks by working on low priority items, critical decisions are taken without team commitment due to a lack of communication, and many agile teams spend little time on reflecting on their work process, thus not releasing the potential of learning.

Team performance has been studied in a number of research fields, like management science and psychology, resulting in teamwork effectiveness models.

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In this article, we are interested in what practitioners in agile development teams perceive as factors that influence team effectiveness. Are established models from other disciplines relevant for agile teams, or do we need to develop our own? This work is a part of a larger research programme on teamwork in agile development, and based on a focus group study, we ask the following research question: *What factors do agile software practitioners perceive to influence team performance?*

This article is structured as follows: In Section 2, we first present central definitions and related work regarding teamwork in general and in particular from the literature on agile software development. We then present the team performance model we use to structure the output from focus groups. Section 3 describes how focus groups were carried out, and how data was gathered and analysed. Section 4 describes the results and findings, in Section 5, we discuss the results through our research questions. In Section 6, we conclude, and state implications for practice, theory and further work.

2 Teamwork and Team Performance

A common definition of a team is "a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable" [4]. In the second edition of the book describing XP, Beck and Andres states that "a variety of people work together in interlinking ways to make a project more effective. They have to work together as a group for each to be successful" [5].

There are a number of studies of teamwork in agile software development, on a range of topics. Some have focused on topics relevant for team composition, like personality [6] and individual characteristics [7]. Others have focused on establishing task-effective norms in groups [8], what motivates team members [9-11], and the importance of a team vision [12]. Yet others have focused on how teams use daily stand-up meetings to communicate [13], how teams make decisions [14], and how to achieve self-management [15, 16]. Some have suggested frameworks to assist improvement of teamwork [17, 18].

Another stream of research has focused on team performance in agile software development teams. Team performance refers to evaluations of the results of the teamwork. Such results are: The quality of the developed software, the ability of the team to meet project goals and budgets and the motivation of team members to work together in the future. Moe et al. used two team performance models to explain teamwork in a project adopting Scrum: The Salas et al. model [19] and the Dickinson McIntyre model [20]. Melo et al. used the "Input Process Output" model to identify team productivity factors in a multiple case study [21]. For a further discussion of team performance models, see [22].

In the general teamwork literature, we find a number of team performance models. Salas et al. [23] identify 136 models and frameworks in a literature review. However, there is a lack of consensus concerning the conceptual structure of teamwork behaviours [24]. Some have criticized that studies of teamwork have been fragmented and not suitable for practical use [25]. A recent review of this body of research by

Salas et al. [25] tries to answer this critique and make the studies practically usable, suggesting the "Big Five" core components of teamwork. Other strengths of the Salas model is that it originates from a solid literature review, and is one of the most cited team performance models.

Salas et al. [25] argue that teams require a complex mixture of factors that include organizational support and individual skills, and also teamwork skills. Therefore, Salas et al. have condensed the knowledge on teamwork into the "Big Five" framework. The five components are: team leadership, mutual performance monitoring, backup behaviour, adaptability, and team orientation. Each of the "Big Five" is required for team performance, but each component may be manifested differently across most teams task types because of constraints of team task and varying needs of the team [25]. The "Big Five" require three coordinating mechanisms: shared mental models, closed-looped communication, and mutual trust.

Building on the theoretically and empirically grounded "Big Five" framework, we describe each component of the framework in Table 1.

Table 1. Definitions of teamwork components in the "Big Five" teamwork model by Salas et al. [25]

Teamwork component	*Definition*
Team leadership	Ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team knowledge, skills, and abilities, motivate team members, plan and organize, and establish a positive atmosphere
Mutual performance monitoring	The ability to develop common understandings of the team environment and apply appropriate task strategies to accurately monitor team-mate performance
Backup behaviour	Ability to anticipate other team members' needs through accurate knowledge about their responsibilities. This includes the ability to shift workload among members to achieve balance during high periods of workload or pressure
Adaptability	Ability to adjust strategies based on information gathered from the environment through the use of backup behaviour and reallocation of intrateam resources. Altering a course of action or team repertoire in response to changing conditions (internal or external)
Team orientation	Propensity to take other's behaviour into account during group interaction and the belief in the importance of team goal's over individual members' goals
Shared mental models	An organizing knowledge structure of the relationships among the task the team is engaged in and how the team members will interact.
Mutual trust	The shared belief that team members will perform their roles and protect the interests of their team-mates
Closed-loop communication	The exchange of information between a sender and a receiver irrespective of the medium, where the information is received

3 Method

We conducted 18 focus group sessions to investigate our research question. Some of the advantages of focus groups include the ability to collect large and rich amounts of

research data, that the researcher can interact directly with respondents for clarification of responses or follow-up questions and that focus group participants can react to and build upon responses from other focus group members [26]. Focus groups are applicable to quickly obtain information on emerging phenomena through structured, moderated discussions with groups of practitioners. We now describe the main steps of conducting the focus groups:

Planning: For each focus group, we developed a plan, which included the agenda of the day and a set of exercises for the participants. Each workshop was planned for 90 minutes and included the following agenda items:

1. Introduction: Purpose and overview of the workshop, motivation for the importance of teamwork in software development.
2. Group exercise 1: Brief introduction of all group members, completion of context questionnaire for each participant. Brainstorm on "*What fosters effective teamwork"* (documented on green stickers), and then on "*What hinders effective teamwork"* (documented on yellow stickers).
3. Presentation team performance model: The research-based Salas et al model.
4. Group exercise 2: Presentation of results from the brainstorm session within groups, categorization of stickers according to the model of team performance. Moderated discussions in the group on placement of stickers.
5. Summary: Presentation of results of the group, feedback on the workshop, information on minutes and further research on teamwork.

Recruitment: In total 92 persons participated in the 18 focus groups. Three were conducted at conferences on agile software development: Two at the Norwegian agile conference (Smidig 2011 and Smidig 2012), and one at XP2012. The participants signed up for a workshop on "Effective Agile Teamwork", and were divided into groups on arrival. Smidig 2012 had five groups, Smidig 2012 three, and XP2012 three. There were 4-6 participants in each focus group.

In addition we conducted focus groups within four companies that participated in a research project on effective teamwork in Norway. In two of the companies the participants included whole projects, while in one company we divided the whole development department into three focus groups. In the fourth company, participants were recruited for a focus group after working hours, which resulted in another two groups with members from a variety of projects.

From the context questionnaire that all participants filled out, we see that the participants were mainly software developers (39%), followed by Scrum masters (18%), team leaders (12%) and project managers (10%). Most of the participants were using the Scrum software development method (59%), followed by Kanban (22%), Lean software development (9%) and eXtreme Programming (8%). As for gender, 65% were male, and 35% female. The participants worked in teams with 3 to 20 members (average 8.4, standard deviation 3.2). The teams had on average 6.6 full time members (standard deviation 3.1). Further, the teams the participants worked in were collaborating with up to 35 other teams. However, 55 participants were working

in teams that did not collaborate with other teams. The participants had on average 11.9 years of experience with software development (standard deviation 8.4), and 4.3 years with experience with agile software development (standard deviation 2.5).

Conducting the focus group: The rooms were set up with one table per group. Walls were covered with flip-over charts with numbered areas for grouping of stickers from the brainstorming session. Groups were given stickers in the right colour at the start of each task in order to avoid that participants confused the colours. An example of room set-up is given in Figure 1. At stage 4 in the agenda, groups were given a sheet explaining the teamwork model.

Fig. 1. Room set-up with one table per group and space for documenting results on flip-overs on walls

Moderation: The focus groups were moderated by the first author during agenda items 1, 3 and 4, and by both authors by discussing with groups during items 2 and 4. The discussions mainly involved deciding where to classify items in the team performance model.

Documentation of results, processing and analysis: We made minutes from all focus groups by taking pictures of the final results, showing groups of items that *foster* or *inhibit* team performance. This was documented for each teamwork component in the model, and we also documented items that did not fit into the model, see Figure 2 for example results from one group at the XP2012 conference workshop.

Fig. 2. Partial results of focus group for teamwork component "closed-loop communication" Items that *fosters* teamwork in green, items that *hinders* effective teamwork in yellow

In total, the groups found seven items that they were not able to fit into the model. These were classified by the researchers. Examples of such items were "teamsize" and "too difficult work tasks" what were moved to team leadership. The minutes were sent to all participants. Then, we recorded items, whether they were marked as *fostering* or *hindering* teamwork in a spreadsheet. The text on four stickers were unreadable in the minutes, and this left a total of 1183. These were first read to check that the topics identified was categorized into the right teamwork component. 17 items were moved from one component to another.

The questionnaire that all participants filled out was also coded in a spreadsheet, to provide descriptive statistics of the participant population.

Analysis included a quantitative and qualitative part. The quantitative analysis consisted of counting the number of items marked as fostering or hindering teamwork. The qualitative analysis consisted of thematic grouping of items marked within each teamwork component. For example, in Figure 2, the stickers "communication barriers within the team" and "direction communications without barriers" (in the upper left corner) were coded as teamwork component "closed-loop communication", while "distances" and "different working hours" were coded as sub-component "co-location. The names of sub-components were all stated as if they were factors that foster team performance, for example most of the stickers identified in the brainstorming for the subcomponent "planning" was aspects of "bad planning".

4 Results

The result of our grouping of items into teamwork components is shown in Table 2. In total 1183 items were placed in the eight teamwork component groups. We see that team leadership, closed-loop communication and team orientation received the highest numbers of stickers indicating items that foster team performance. Closed-loop communication, shared mental models and mutual trust received the largest

Table 2. Number of stickers with items *fostering* or *hindering* team performance, and the number of items considered as most *important* by the focus groups. Numbers are shown for each teamwork component.

Teamwork component	*Foster*	*Hinder*	*Total*
Team leadership	90	139	229
Mutual performance monitoring	49	22	71
Backup behaviour	44	57	101
Adaptability	46	50	96
Team orientation	91	65	156
Shared mental models	104	59	163
Mutual trust	97	58	155
Closed-loop communication	122	90	212
Sum	*643*	*540*	*1183*

numbers of items that could hinder team performance. Further, closed-loop communication mutual trust and shared mental models received the highest numbers of markers indicating that participants viewed these as important.

For the qualitative analysis, we have chosen to display results from the two groups with highest total number of items identified: Team leadership and closed-loop communication. Note that many stickers only shows that many are aware of this factor, it is not necessarily an important factor.

Team leadership: This component includes 139 items that foster effective teamwork, and 90 that hinders effective teamwork. 66 stickers simply described "leadership" (14 fostering and 52 hindering). See Table 3 and Figure 3 for a grouping of both fostering and hindering items.

Table 3. Main sub-components of team leadership, with selected items that foster and hinder team performance

Sub-Component	*Items*	
	Foster	*Hinder*
Planning	Good planning	Bad planning
	Participative planning	Too thorough planning
	Adequate planning	Short-sighted planning
Shielding from interruptions	Reduce unnecessary interruptions	Interruptions
	Shielding the team	Work day split up
	Someone protecting the team	Change the agreed content
Work processes	Slack to think big	Heavy process
	Responsibility process in place	Unnecessary processes
Adequate resources	Full time members	Part-time resources
	Capacity	Lack of resources
	Availability	Resource allocation
Infrastructure	Working infrastructure	Lack of tools
	Good work conditions	Lack of technical infrastructure
	Access to tools	Unnecessary tools

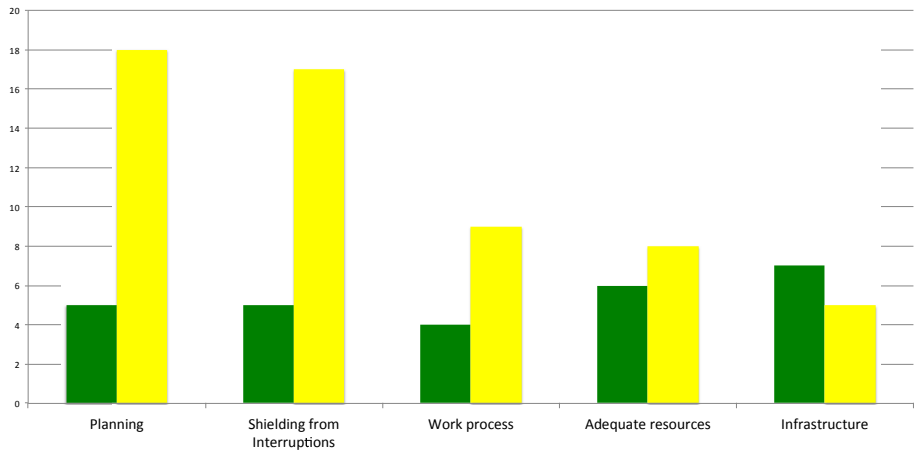

Fig. 3. Characteristics of *team leadership*. For each subcategory, the number of items marked as *fostering* to the left and the number of items marked as *hindering* to the right.

In addition we find the following groups with more than three items: "team members take responsibility", "team composition", "interesting work tasks", "social atmosphere", "well defined tasks", "engaged team members", "absence of conflicts", "balance between team members", "common goals", "frequent communication", "focus on setting priorities", "having the right focus", "self management", and "visualising status and progress".

Table 4. Main sub-components of closed-loop communication, with selected items that foster and hinder team performance

Sub-Component	*Items*	
	Foster	*Hinder*
Co-location	Physical presence Co-location Physically placed together	People are distributed Distance Not co-located
Openness	Open communication Openness in the team Open dialogue	Secrecy Retaining information
Infrastructure	Process support tools Suitable office spaces Tools that work	Bad tools Bad office facilities
Visualising status and progress	Informative workspace Visualise things that go well Whiteboard/taskboard	No whiteboards
Social atmosphere	Good atmosphere Fun Friendly tone	Scolding Antisocial environment Bad atmosphere

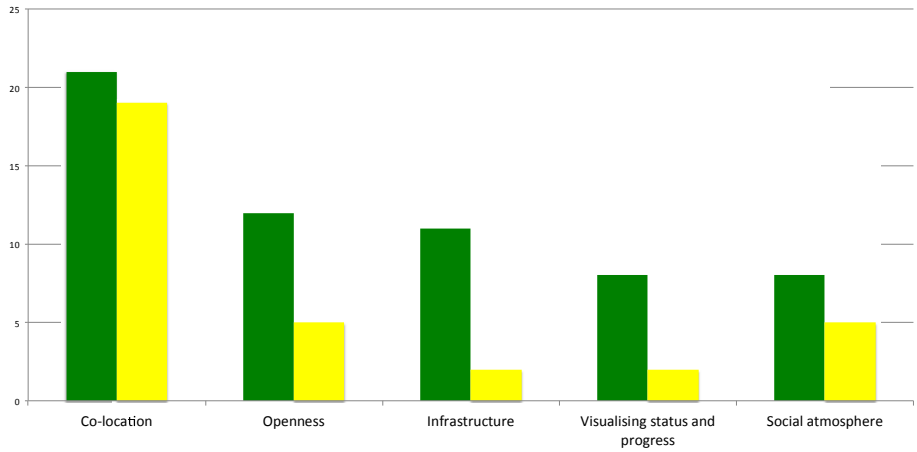

Fig. 4. Characteristics of *closed-loop communication*. For each subcategory, the number of items marked as *hindering* to the left and the number of items marked as *fostering* to the right.

Closed-loop communication: This component includes 90 items that foster effective teamwork, and 122 that hinder effective teamwork. Many stickers simply described "communication", in total 63 (23 hindering, and 40 fostering). See Table 4 and Figure 4 for a grouping of both fostering and hindering items. The sub-components that received the highest number of items indicating factors that both foster and hinder effective teamwork was "co-location", "openness", "infrastructure", "visualizing status and progress", and a "social atmosphere".

In addition to these five groups, we also find the following groups with three items or more: "frequent communication", "absence of conflicts", "absence of interruptions", "absence of introvert team members", "customer available", "common language and culture", "team leadership", "slow response" and "follow-up".

5 Discussion

We now proceed to discuss our research questions: *What factors do agile software practitioners perceive to influence effective teamwork?*

From the results section and Table 2, we see that the results of the focus groups fitted well into the general research-based model of team performance. The participants themselves only put 7 out of 1183 items in an "other" group, and these were later categorized by the researcher into the team components. If we interpret the number of stickers generated by all groups for a teamwork component as a sign of the perceived significance for team performance, we see that the components cluster in three groups: *Team leadership* and *closed-loop communication* have 229 and 212 items respectively. S*hared mental models*, *team orientation,* and *mutual trust* have

around 160 items. The last group of components: *backup behaviour, adaptability* and *mutual performance monitoring* range from 71 to 101 items (Table 2).

In their description of the "Big Five" model, Salas et al. [25] suggest that *team leadership* and *team orientation* will be especially important in the initial stages of team development, when the team is exploring their task interrelationships and the roles of team members. If we divide teamwork into phases, Salas et al. hypothesize that *adaptability, team orientation* and *closed-loop communication* will be the most important before engaging in complex tasks. Then *mutual performance monitoring, backup behaviour* and *adaptability* are expected to increase in importance as the team is working on the tasks. It is interesting that there were not more stickers related to *adaptability*, as this is central in agile software development. Maybe this is something the participants take for granted in agile development.

The practitioners who participated in focus groups emphasized many of the same factors as Salas with *team leadership, closed-loop communication,* and *team orientation.* Components that are given attention by Salas, *adaptability*, *mutual performance monitoring*, and *backup behaviour* are given less attention by practitioners.

In a study of an agile development team introducing Scrum, Moe et al. [20] found that *team orientation, team leadership* and *backup behaviour* was particularly challenging. The first two are given much focus by practitioners, while the third receives less attention. A multiple case study in two companies by Stray et al. [3] discovered challenges related to communication (*closed-loop communication*), learning (*shared mental models*, *backup behaviour*) and selecting the tasks according to the priority list (*team orientation).* Compared to our focus group findings, we see that team orientation and closed-loop communication jointly receives much attention, while the practitioners place less emphasis on backup behaviour (shared mental models in the mid-range).

If we go further into details, we will compare the definition *team leadership* by Salas to the sub-components identified by agile development practitioners in the focus groups (Table 5). From the sub-components, we find a number of topics related to directing and coordinating the activities of team members, like "planning", "common goals", "self management", "focus on setting priorities", "frequent communication" and "visualising status and progress". The latter is also related to assessing team performance. Related to assigning tasks, we find "adequate resources", "well defined tasks" and "self management". We do not see sub-components that we can connect to "developing team knowledge, skills and abilities". Maybe this could be because many include this in their definition of a "self managing" team. As for motivating team members, we have "engaged team members", "interesting work tasks" and "absence of conflicts". The last item in Salas et al.´s list is to plan, organize and establish a positive atmosphere. Here we have "planning", "infrastructure", "team composition", "shielding from interruptions", "balance between team members", "work process" and "social atmosphere". In all, it seems like the participants in focus groups have an understanding of team leadership which is similar to the one described in Salas et al., with the exception of focus on "develop team knowledge, skills and abilities".

Table 5. Team leadership, definition by Salas et al. and sub-components identified in focus groups. The list of sub-components is according to frequency, with the sub-components with most items listed first.

Sub-components from focus group	Planning, shielding from interruptions, work process, adequate resources, infrastructure, team members take responsibility, team composition, interesting work tasks, social atmosphere, well defined tasks, engaged team members, absence of conflicts, balance between team members, common goals, frequent communication, focus on setting priorities, having the right focus, self management, visualising status and progress
Definition by Salas et al.	Ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team knowledge, skills, and abilities, motivate team members, plan and organize, and establish a positive atmosphere

If we do a detailed examination of *closed-loop communication*, the definition by Salas et al. is simply that a sender and a receiver exchanges information irrespective of medium (Table 6). The sub-component "co-location" received in total 40 stickers with either co-location promoting effective teamwork or the lack of co-location hindering effective teamwork. It seems then that many teams perceive co-location as important for good communication. Also, a number of other sub-components were related to the set-up of the team, like "infrastructure", "visualising status and progress". A number of sub-components focused on the quality of communication: "openness", "frequent communication", "absence of conflicts", "absence of interruptions", "customer available", and that there should not be "slow response". Some emphasized that good communication requires a "common language and culture" and a "social atmosphere". Some also included "follow-up" and "team leadership" here, the latter indicating a special role for a team leader with respect to ensuring good communication. To summarize, practitioners in agile development teams seem to place much emphasis on physical and technical infrastructure as enablers of closed-loop communication, shown by many stickers with topics in sub-components co-location, infrastructure, visualising status and progress.

Table 6. Closed-loop communication, definition by Salas et al. and sub-components identified in focus groups. The list of sub-components is according to frequency, with the sub-components with most items listed first.

Sub-components from focus group	Co-location, openness, infrastructure, visualising status and progress, social atmosphere, frequent communication, absence of conflicts, absence of interruptions, absence of introvert team members, customer available, common language and culture, team leadership, slow response, follow-up
Definition by Salas et al.	The exchange of information between a sender and a receiver irrespective of the medium

One question is what would have happened with our analysis if we had used another team performance model? Note that we conducted the brainstorming session on what fosterer and hinder effective teamwork (items 2 on the agenda) independent of any model. The model was first introduced when all items related to team performance had been introduced. We expected a larger number of items that the focus group participants would not be able to relate to the model, as the Salas et al. model is focused on a practical model with a limited number of factors. For example the "Input Mediator Output" model [27] has a far larger number of factors, like characteristics of team members with respect to diversity and emergent states of a team, like "empowerment" and "cohesion". However, it would be an interesting task to analyse the material with respect to other models to see if they are fitting equally well.

6 Conclusion

In this article, we report findings from a focus group study on how team performance is seen by practitioners in agile software development teams. We conducted 18 focus groups with a total of 92 participants, where participants brainstormed on factors that foster or hinder teamwork, and relate this to the Salas et al. model of team performance. We asked the following research question: *What factors do agile software practitioners perceive to influence effective teamwork?*

Our main findings are the following:

- The Salas model seem to fit well with what practitioners perceive as factors that affect team performance. Only 7 of 1183 stickers were not placed in the model by the groups (and all of these were later found to fit by the researchers).
- After number of stickers identified, the teamwork components cluster in three main groups: 1) *team leadership* and *closed-loop communication,* 2) *shared mental models*, *team orientation,* and *mutual trust,* 3) *mutual performance monitoring, backup behaviour* and *adaptability.*
- *Backup behaviour* has been found to be challenging in studies of agile development teams, and is one of the components with the lowest number of stickers. This could indicate a lack of awareness of this factor with respect to team performance.
- The practitioners understanding of *team leadership* seems similar to description in Salas et al. [25], except for a lack of focus on "develop team knowledge, skills and abilities".
- Further, practitioners in agile development teams seem to place much emphasis on physical and technical infrastructure as enablers of *closed-loop communication*, shown by many stickers with topics in sub-components co-location, infrastructure, visualising status and progress.

This study has the following implications for theory: First of all this study confirms previous findings from case studies showing that general theory on teamwork is of high relevance to agile software development teams. Second, this focus group

suggests that team leadership is perceived as important, and practitioners' view of team leadership corresponds to how it is described in the team performance model of Salas et al.

Implications for practice are that much of the advice given in general team research will be relevant for agile software development teams. In particular what agile teams should focus more on in order to enable team performance is *backup behaviour*, which receives little attention in this study and has been shown in case studies to be problematic.

This focus group study has the following limitations: First of all, the opinions on team performance expressed by the focus groups might diverge from a representative sample of agile development practitioners. 67% of participants signed up voluntarily for the focus group workshops, either in a company or in one of the three conferences. Thus, our participants are likely to be more than averagely interested in teamwork. Second, focus groups are often criticized for enabling groupthink. For collecting items that foster or hinder team performance, we avoided this effect by individual brainstorming sessions. However, in the discussions where groups placed items in the Salas model, groupthink might influence placement. We tried to minimize this effect by critically examining the results of the groups and moving 17 items from one teamwork component to another. For the analysis, one could argue that the "Big Five" model should be replaced by another teamwork model, as agile teams are said to be self-managing and this model is not particularly tailored for self-managing teams. However, we argue that first of all, many teams that use agile development methods are not self-managing. Second, we can interpret the team leadership tasks as tasks that are the responsibility of the whole team and not of a team leader for teams that are self-managing.

In the future we plan to carry out a detailed analysis as we have done for the two main teamwork components for all teamwork components in the model. We hope then to be able to identify even further characteristics of what agile practitioners perceive as important in teamwork, and what might differentiate from what researchers or team members in other disciplines see as important.

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