A process oriented exploration of participatory roles and regulation in Scrum teams

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Abstract

The purpose of this study was to explore the temporal nature of individual contributions to socially shared regulation. The focus was on regulatory activities and participatory roles people play out in Scrum meetings and their relationship to successful team decision making. By means of camera recordings we analyzed the regulation activities and roles team members play out in five Scrum teams. Chi-square tests and a process mining method called 'Fuzzy Mining' were used to interpret the data. Results show that team members often follow up on each other's regulation activities and only seldom change activities within a discussion. Less change in regulation activity is found in effective decision making than in ineffective decision making. However, effective decision making is accompanied by a more varied distribution of participatory roles than ineffective decision making. Further, the distribution of roles varies among regulation activities and decision making instances.

1. Introduction

1.1 Problem statement

From the first steps taken in primary school to a life spanning professional career, people need to cooperate. In organizations cooperation between employees is of great importance for a productive outcome and employee satisfaction (Moe, Dingsoyr, & Dyba, 2008; Rousseau & Aubé, 2010). Teams often work more effectively when they are allowed to manage and set their own goals (Rising & Janoff, 2000). Ideally, employees should be communicating in such a way that everyone within a team knows what goals are to be met and how work is distributed among colleagues (De Dreu & Weingart, 2003; Edmonson, 1999). But methods of cooperation in organizations vary and so does the productivity of cooperation. Self-organizing teams were found to often fail due to a lack of support or goal setting and management (Moe et al., 2008; Edmonson, Dillon & Roloff, 2008).

A recent trend in organizations is agile working. Its basic idea is that teams should be very flexible and should be able to quickly shift attention from one project to another (Moe, Dingsoyr, & Dyba, 2010). IT companies often use an agile work method called 'Scrum'. Scrum teams work without a direct supervisor and are required to regulate goals and work distribution themselves. These teams show an increased performance over teams directly managed by a supervisor (Moe, et al., 2008; Rising & Janoff, 2000). Even teams outside the IT world have started implementing scrum team work methods recently (Rousseau & Aubé, 2010). However, it is not yet fully understood what factors affect the scrum methods effectiveness (Moe et al., 2008).

Within agile working regulation is an important aspect (Moe et al., 2008). Regulation is defined as the monitoring and regulation of one's own behavior and cognitive activities towards a goal (Lord, Diefendorff, Schmidt & Hall, 2010; Hadwin & Oshige, 2011; Schoor, Narciss & Körndle, 2015). Theory on regulation, often called self-regulation, has expanded to also cover social aspects, in which individuals regulate together to achieve team goals process (Hadwin, & Oshige, 2011; Järvelä & Hadwin, 2013). This shared regulation is mostly studied on team level, without paying attention to who regulates what and how individuals regulate in relation to one another. The way in which individual contributions influence the regulation of the team is not yet fully understood (Volet, Vauras, Salonen, & Khosa, 2017). Using individual contributions to study team regulation is relatively new, and yet only conducted in few studies (Van der Haar, 2013; Edmonson, 1999). Calls for this integration of individual and group analyses are widespread, but studies are few (Volet, et al., 2017; Van der Haar,

2013; Edmonson, 1999). Apart from that, many studies also focus on school settings, indicating a gap between school and workplace team contexts (Tynjälä, 2008; Acuña, Gómez & Juristo, 2009.

The study presented in this thesis contributes to the knowledge base on regulation, by combining analyses on both the individual and the group level. We intend to explore the processes of individual contributions to shared regulation. Using a process oriented approach, we will analyze the roles individuals perform and group regulation within Scrum team meetings in a workplace context.

1.2 Theoretical framework

1.2.1 Social regulation

Regulation is the process of monitoring and regulating one's own behavioral, motivational and meta-cognitive aspects of learning, with a goal, standard or achievement in mind (Pintrich, 2000; Lord, et al., 2010; Hadwin & Oshige, 2011; Schoor, et al., 2015). The goal or task is therefore a determent of how regulation occurs within teams or individuals. Regulation is described as a feedback loop in which teams or individuals compare their current state to their desired state or goal. This allows them to then regulate their work in multiple ways. For example directing attention, managing time or motivation, and other aspects can all be altered by regulation activities (Lord et al, 2010; Duffy et al., 2014). Regulation as an event does not happen automatically; it should be seen as intentional activity that is initiated when need arises (Sobocinski, Malmberg & Järvelä, 2017; Hadwin & Oshige, 2011).

Regulation can occur on different levels. There is a distinction between self-, co- and shared regulation. Self-regulation is the monitoring and regulation of the aspects of one's own behavior. It was long the only type of regulation that was taken into consideration, but new insights found regulation to also be a social process (Hadwin, & Oshige, 2011; Järvelä & Hadwin, 2013). Social forms of regulation are co-regulation and shared regulation. Co-regulation happens when one person regulates the activities of another person by interaction. These people do not have equal roles, as one regulates and the other is regulated. An example of this would be a teacher regulating a child's learning. Shared regulation implies that multiple others share a problem. This problem leads to interaction within the whole group, in which the goals and standards are co-constructed and then regulated (Hadwin & Oshige, 2011; Schoor et al., 2015). In shared regulation people do not differ in relation: all persons are theoretically equal. It should be noted that there is interchangeability in terms used for shared regulation (Schoor et al., 2015; Volet, et al., 2017). Research on regulation often uses the term

self-regulating teams when in fact, these teams use shared regulation. Often, within group work self-, co-, and shared regulation can all be found, implying that individual contributions to shared regulation are of importance. (Hadwin & Oshige, 2011; Volet, Summers & Thurman, 2009).

Within regulation activities different phases and directions have been discerned. These phases are the planning, monitoring and evaluating phase (Rogat & Linnenbrink-Garcia, 2011; Azevedo, Moos, Greene, Winters & Cromley, 2008; Zimmerman, 1990). The planning phase is characterized by orientation. A planning on upcoming labor is created by determining strategies and goals. In the monitoring phase the progress of the task is assessed. In this phase it is checked whether work is on schedule and according to the plan. Goals and planning may be revisited. The evaluation phase entails judgment and possible improvements for a next time. Apart from regulation phases, the direction of the regulation activity is also an important factor of regulation research (Rogat & Linnenbrink-Garcia, 2011; Grau & Whitebread, 2012). Discerning what the activity is directed at allows for a deeper understanding of the observed regulation activity. Direction of activity is directed at either the task or project that is to be performed, the organization of the meeting, or the organization of collaboration (Wijga & Endedijk, 2016; Grau & Whitebread, 2012).

Including regulation phases and directions in regulation research allows for a more in depth study of regulation, but may also bring to light detailed information on the temporal nature of regulation. There has been an explicit call for temporal studies that focus on more detailed levels of regulation (Schoor & Bannert, 2012). Many regulation theories imply a time-ordered model in one way or another, but empirical evidence has not yet been found (Grau & Whitebread, 2012; Schoor & Bannert, 2012; Azevedo, 2009). Recently, small steps towards uncovering the sequential and temporal nature of regulation activities were taken (Schoor & Bannert, 2012; Reimann, Frerejean & Thompson, 2009). For example, Schoor and Bannert (2012) compared the regulation process of high and low performing groups. They found that the monitoring phase was of great importance in the process for both kinds of groups, but that high performing groups showed more orientation and evaluation activities than low performing groups. Another study showed that high performing groups varied their regulation activities more than low performing groups (Malmberg, Järvelä, Järvenoja, & Panadero, 2015). This form of temporal regulation research was, to our knowledge, conducted only in school settings, using only very small samples. We were unable to find any temporal regulation studies on workplace learning.

Many studies regarding social regulation have been performed in a school setting (Tynjälä, 2008; Acuña et al., 2009). But learning in a school context and learning at the workplace differ in a couple of ways. Workplace learning is mostly informal, less structured and often involves learning of groups and teams (Tynjäla, 2008). Students in schools often learn in a more structured environment with a teacher and a set curriculum. Students also work with students of the same age and educational level. These contextual differences may imply that shared regulation may function differently in a more informal workplace environment than in schools and student teams.

1.2.2 Participatory roles

In order to identify individual contributions to social regulation activities an investigation of the research of Volet et al., (2017) and Chiu (2000) is made. Volet et al. (2017) studied shared regulation with regards to individual contributions within student teams. Based on fundamental work of Benne and Sheats (2007) and Chiu (2000) they found team members may play out different roles in teams.

Roles identified by Volet et al. (2017) are focused on either content, performance, evaluation or social interaction. Content, performance and evaluation focused roles are task-oriented, while social roles are not. Content focused roles were found to be *information seeker*, *information giver*, *knowledge seeker* and *knowledge provider*. Seeking respectively information and facts or deeper knowledge on effects and relations. On the other side are the contributors of such content, these roles were found to be carried out spontaneously by all group members in high performing groups. Performance focused roles consisted of the *opinion seeker* and *opinion giver*. The *opinion seeker* typically invites other to give their opinion on procedures and decisions and this role was found to be played by only one individual within a team. The *opinion giver* expresses an opinion on procedural matters. Roles focused on evaluation are *follower, supporter* and *challenger.* The *follower* is a neutral role, who either agrees or is indifferent to suggestions made. The *supporter* repeats suggestions made and may add clarity to them. The *challenger* opposes both previous roles and is critical of prior suggestions. He may either disagree or ask for clarification. The social role was that of *harmonizer*. He tries to have a positive effect on atmosphere in the team by joking or solving conflicts. In total Volet et al. (2017) identified ten participatory roles in their study on student teams.

These roles were found to influence the quality of regulation on the team level, and with that, group performance. Roles students play out when interacting in teams will therefore influence the amount and quality of regulatory activities within these teams. Roles were found to be flexible, dynamic and evolving towards different expectations in all examined groups. But effective teams showed team members that were able to switch to different roles quickly, while less effective teams were less flexible and with limited variation between roles. More research on these roles is required, as studies on the topic are very scarce. What exactly the benefit or disadvantage of having such roles in a team is, remains for the most part unclear. This is especially true in workplace settings, which were, to our knowledge, never studied using this theory.

1.2.3 The influence on performance

The goal of this study is to increase performance in Scrum settings. However, the outcome of IT teams is not easily assessed in a cross sectional study, as many different internal and external factors are at play that may influence outcomes in one way or another (Decuyper, Dochy & Bossche, 2010; Reimann et al., 2009). Especially when only addressing workplace team meetings instead of an assessment of actual outcome. Performance is more easily measured in school settings, where it is assessed continuously by means of grades and assessments (Tynjälä, 2008). It is more difficult to measure performance in a workplace setting, where no grades and continuous documented assessments are present. Therefore, a way of measuring performance in Scrum meetings is needed.

An important finding is that decision making is a big influencing factor in team effectiveness, but also a very complex one (Poole & Roth, 1989; Reimann et al., 2009). Efficient teams come to a decision more often than ineffective teams (Decuyper et al., 2010). Reaching an agreement is a form of creating a shared mental model within a team. The shared mental model is a term commonly found in team learning literature (Decuyper et al., 2010; Edmonson, Dillon & Rollof, 2008) and is an important aspect of team learning (Van den Bossche et al., 2006). We believe that identifying whether teams come to an agreement at the end of a discussion may be an effective method of assessing team efficiency.

1.3 The present study

This study aims at investigating the adoption of participatory roles by individuals in Scrum teams, and an additional focus on regulation activities found. In particular, an investigation is made on what participatory roles merge in Scrum team meetings, and how these roles effect team learning and performance. We focus on the sequential patterns of both regulation and participatory roles, using a process oriented method. The goal is to gain insight and possible methods of supporting Scrum teams to enhance performance and to contribute to the body of knowledge on regulation and participatory roles, by exploring the gap in knowledge regarding sequential patterns. We aim to answer the following research questions:

1. How do Scrum teams jointly regulate their meetings and when is this done successfully?
2. How are participatory roles played out in Scrum team meetings?
3. How do participatory roles contribute to successful regulation of team meetings?

2. Method

2.1 Research Design

This study is an exploratory field study, analyzing five different scrum teams in a Dutch software company. The goal is identifying different roles individual team members play out in shared regulation and analyzing their effects in terms of benefit or dysfunction. Whether conversations are contributing to effectiveness or not is determined by decision making outcome, as described in the coding scheme below.

2.2 Context and participants

The present study was conducted among scrum teams. Scrum is an agile method, meaning that the teams should be flexible and easily shift focus between projects and work (Moe et al., 2010). Specific to scrum is the organization of the project, which is done in sprints. A sprint is a period of approximately three weeks, in which the team attempts to attain project related goals. A sprint starts with a planning meeting, in which the goals are selected. Every day, the team gathers in a (short) stand-up meeting, in which they inform the other members about their progress and impediments. Refinement sessions are held once or twice during the sprint, to alter and refine team goals. Lastly, retrospective meetings are conducted in which the team reflects and evaluates team goals (Moe et al., 2008; Moe et al., 2010). In total, five scrum teams within an organization developing software for the Dutch government participated in the study. The number of participants was 33 (30 male, 3 female). Age varied from 27 to 54 years old.

2.3 Procedure

First, it should be noted that data collection was carried out by other researchers. Their first step to collect data was holding a presentation to inform the scrum teams of a software developing organization. This presentation presented the goal of the study, as well as time investment required, the method of data collection and privacy monitoring. Team members could sign up individually after this presentation. Only groups in which all team members individually consented participated in this study. Should one or more team members have declined, the whole team would have been excluded from the study to ensure privacy.

Agile team meetings were recorded using 360 degree cameras. A pilot was conducted for the duration of two weeks to ensure that the cameras were not distracting team members. If team members and the researcher both deemed the data collection method proficient the

study would be continued. Team members had another chance of resigning from the study after this pilot, or signing an informed consent form, meaning they were willing to participate.

All meetings of two sprint periods per team were planned to be recorded. Due to meetings being parallel, the researcher was not able to attend all meetings. Teams were therefore instructed on how the camera worked so that they were able to start the record without availability of the researcher. Unfortunately, not all meetings were recorded due to unavailability of the camera or forgetting to switch on the camera. The large amount of collected video's, especially stand-ups, led to the decision of not coding all available video's. An even number of meetings per team and meeting variety was pursued. Meetings within one sprint session were used as much as possible. Due to meetings not being conducted or recorded and some technical difficulties a perfect distribution was impossible. An overview of the coded meetings can be found in Table 1.

Table 1. *Overview of coded team meetings.*

Meetings	Team 1	Team 2	Team 3	Team 4	Team 5	Total
Planning	1	1	1	1	1	5
Refinement	1	1	1	0	1	4
Retrospective	2	2	2	1	0	7
Stand-up	7	5	5	5	5	27
Total	11	9	9	7	7	43

2.4 Data analysis and instruments

The first research question is answered analyzing frequencies of utterances coded as regulation. Chi-square tests and the process mining tool 'Fuzzy model' will be used as means to answer how regulation occurs in scrum meetings. To discern between effective and ineffective decision making, also the wrap-ups will be compared. Our second question is answered by analyzing participatory roles found in the meetings. The conduction of chi-square tests and a fuzzy model will allow us to analyze possible differences and sequential patterns in roles. Our last question will be based on analyzing the same results based on wrap-ups. We will perform a chi-square test on both regulation and roles to compare them among wrap-ups. Different fuzzy models for both regulation and roles will be made based on wrap-ups.

In order to record team meetings, a 360 degree camera was used. The recordings were coded using a coding scheme and coding software called ´The Observer XT13´, developed by Noldus. Transcribing the meetings was not required, as the software allowed for the direct coding of specific video segments. All utterances within the 43 team meetings were defined

by time stamps and coded according to the coding scheme presented in appendix A. The regulation codes were coded by one researcher and the roles and wrap-ups by another. By comparing and discussing coding results initial agreement was eventually reached on the coding scheme. A final test was then conducted using the coding software to determine the inter-rater reliability. Five stand-ups were recoded and compared by the other researcher, after which the kappa value was calculated.

2.4.1 Coding scheme

Episodes and wrap-ups

The first step was determining episodes. An episode is a period of the first until the last utterance on a certain topic. Episodes could be interrupted by short periods of social talk. The episode itself was also coded with a wrap-up code. The wrap-up is a concept thought up by team learning scholars (Raes, Boon, Kindt & Dochy, 2015), and basically entails the event in which a group closes a discussion with a mutual agreement. Wrap-up possibilities were action, cognitive, no wrap-up, and no wrap-up needed, as adapted from Bron et al. (2019). An action wrap-up was coded when the team reached an agreement on subsequent action. A cognitive wrap-up happened when the team reached consensus on the understanding of information or planning. Also when a team decided to postpone a decision it was determined a cognitive wrap up. No wrap-up was coded when the team was unable to reach an agreement and moved on to another topic. No wrap-up needed was only coded when a team clearly did not need to reach an agreement on a certain topic. An overview can be found in the coding scheme in Table 2. The wrap-ups were used to distinguish between successful and unsuccessful decision making. We deem decision making successful when discourse leads to either an action or cognitive wrap-up. Unsuccessful decision making occurs when the episode is defined as no wrap-up. Logically, successful decision making should lead to higher performance than unsuccessful decision making. Episodes that contain an action or cognitive wrap-up are therefore perceived as successful, while no wrap-up episodes are deemed unsuccessful.

Table 2. *Coding scheme on episodes and regulation.*

Code	Definition	Example
Episodes	An episode is a sequence of utterances about the same topic. It starts with the first and ends at the last utterance on the topic.	
Wrap ups	Every episode is coded with a wrap-up. This is a plan for subsequent action, a conclusion of an agreement, or the summary of a solution.	
Cognitive wrap-up	A cognitive wrap-up occurs when consensus is reached on the understanding of information, theory, or planning. When the team decides to postpone a decision, this is also considered a cognitive wrap-up.	"So, we will give this sprint five points." "Okay, so we will see later on"
Action wrap-up	An action wrap-up is coded when subsequent action is planned after a discussion or conflict.	"Shall we then each prepare some questions before next week?" "So we agree: We will split into much smaller stories."
No wrap	No consent is reached within the team and they move on to another topic without any decision making or agreement.	*A: "We still need to decide what to do with the UI."* *B: Did you already integrate the patch, C?*
No wrap needed	Only coded if there is no wrap-up and the topic clearly does not require one.	
Regulation utterances		
Regulation	Intentional and goal directed group efforts to regulate its conceptual understanding and task work. Collectively shared regulatory processes orchestrated in the service of shared outcome.	"Let's discuss impediments next, but first I'd like to hear B's thoughts on this."
Cognition	Utterances about the content of the task and the elaboration of this content.	"I can't log into the new user interface."
Off-topic	When communication is too hard to understand or the sound is unclear.	
Social talk	Talk not aimed at regulation or team processes.	"I'm playing the wild card now." "Hey, did you come by bike?"

Regulation and non-regulation

After the determination of episodes, all utterances within the episodes were coded on regulation according to Wijga and Endedijk (2016). These regulation codes will be used to answer both the first and third research question. The first step was determining whether an utterance was regulation orientated or otherwise. Should the utterance be non-regulation, a distinction was made between social talk, cognition and off-topic. Social talk was coded when team members made a joke, discussed weekend plans or otherwise socially orientated. Cognition was coded for all utterances that did relate to content of tasks, but not to regulation, such as "I am unable to install the new module". Off-topic was coded when utterances were inaudible or otherwise not related to the discussion, such as when talking on the phone. Regulation utterances were found when they were goal directed group efforts to regulate its conceptual understanding and task work. The overview of this coding can be found in appendix A.

Phases of regulation

When a regulation utterance was found, the phase of regulation was determined following Wijga and Endedijk (2016). This could either be planning, monitoring or evaluation, as is described in Table 3. Planning was coded when the regulation utterance was about how to solve a problem, discuss strategies, translating directions into a clear plan or delegating tasks. Monitoring utterances focused on the goal standard and current state and progress. Evaluation was judging progress towards goals and discussing what could be improved next time.

Direction of regulation

The direction of the utterance was also coded for regulation utterances, conform Wijga and Endedijk (2016). Regulation utterances could be directed at the project the team was working on, the current meeting the team was conducting, or the organization of collaboration. The inter-rater reliability was established by recoding six stand-up meetings (about 13% of the total meetings) and then comparing these. Inter-rater reliability of the coding of wrap-ups, regulation, phases and directions was high at $\kappa = 0.89$.

Table 3. *Coding scheme describing the definitions of regulation phases and directions.*

Regulation phases	Definition	Example
Planning	Discussing how to go about solving problems, discussing strategies, goal setting, collaboratively discussing task directions, translating directions into a clear plan, designating tasks.	"Do you need anything else to finish this task?"
Monitoring	Checking progress and comprehension of the task (I do not understand, you are doing it wrong). Comparing a current state with a desired state (goal standard). Monitoring content understanding, assessing progress, recognizing what remains to be completed, monitoring the pace and time remaining.	"Today I finished some bug testing." "I was unable to do any of that, because the update was not implemented."
Evaluation	Making a judgment about goal attainment. Or discussing what could be improved next time.	"Our collaboration was bad this week. No one seemed to be serious about anything."
Direction of activity	Definition	Example
Project	Regulation directed to planning, monitoring or evaluation of the design processes. Regulation activities on the content of the project.	"I did some testing today" "This patch I have been working on is nearly finished."
Meeting	Regulation activities directed at the practical organization and logistics of the meeting.	"Now you're talking technical. We agreed to do that after the meeting"
Organization	Regulation activities directed at the practical organization and logistics of the collaboration process.	"I'm on holiday next week, so I won't join in."

Roles

The next step is adapted from Volet et al. (2017) and determines the roles individuals play out in their utterances. Coding of roles should lead to an answer on how team members self-assume roles, and what roles are effective in collaboration. The coding scheme is presented in Table 4 and in Appendix B. For this step, we look back on all utterances. We do not strictly focus on regulatory utterances, but also include cognition and social talk utterances. For the roles, a distinction into five categories is made: 'content focused', 'performance focused', 'evaluation focused', 'socially focused' and lastly, 'undetermined'. For content, four different roles were possible according to Volet et al. (2017): 'Information seeker', 'information giver', 'knowledge seeker' and 'knowledge giver'. However, discerning between information and knowledge proved to be difficult, as the terms knowledge and information proved to be nearly the same. It was therefore decided to generalize the four roles into only two: content seeker and content provider. Performance is divided into two roles: 'opinion seeker' and 'opinion giver'. Evaluation has three possible roles: 'Follower', 'supporter', and 'challenger'. The social roles consisted of 'harmonizer' and 'disharmonizer'. While Volet et al. (2017) did not find any disharmonizing utterances in their study in newly formed groups, we decided to include this role as our teams have existed for a longer period of time. Which could have led to dissatisfaction or other dysfunctional relations. A final category was that of undetermined roles, in which we discerned between non-specified and off-topic. Non-specified was used when the utterance was interrupted or inaudible. Off-topic was coded when the utterance was not part of the conversation. Inter-rater reliability was established by recoding five stand-up meetings (10% of the total meetings) and then comparing them. Inter-rater reliability was found to be high ($\kappa = 0.94$) for role coding.

Table 4. *Coding scheme describing the definition and examples of participatory roles.*

Code	Definition	Example
Content focused (CF)	Content focused roles focus on information, facts and knowledge.	
Content seeker	Seeks for facts, information or knowledge related to content. May ask questions to deepen own understanding or may invite others to speak about content.	"How does that work?" "What did you do?" "Can you say something about that?"
Content provider	CP offers facts, information or knowledge on content. Can also be in question form, when seeking confirmation.	"We did this and that, right?" "I checked to see if X works the other way around too"
Performance focused (PF)	Procedure focused roles express opinions on procedural matters.	
Opinion seeker (OS)	Invites others to express their opinions in something dominantly related to procedures. OS may want to know which alternative should be chosen, or how the team should proceed or initiate a new procedural approach.	"What do you think we should do? " "Is it possible to do it like this?" "What do we do with definitions?"
Opinion giver (OG)	OG expresses an opinion. For example, by telling which solution, alternative or approach the group should choose. Can be in question form when seeking confirmation. May also evaluate previous procedures, stating what he thought worked well. OG may also state brief opinions as 'it will probably work out anyway'. OG does not challenge someone else's opinion or criticizes, like challenger does..	"We should try to do that first." "Don't you think we should try X?" "I would advise to do X, because..."
Evaluation focused (EF)	Evaluation focused roles react to previous statements.	
Follower (FO)	Either agrees or is indifferent with suggestions made or information provided in a short sentence. FO is only coded when one is not just listening actively (humming, nodding, or saying yes while other is talking), but explicitly replying to a previous comment. This can be just acknowledging or replying doubtingly.	"I see." "Oh, okay." "Right."

Supporter (SU)	SU clearly agrees with previous statement. May state supported statement in other words to further clarify or present short supportive additions or proposals. SU only supports comments of other team members.	"Yes, finish the screen first." "Exactly!"
Challenger (CH)	Puts previous comments to the test by asking for clarification or disagreeing with suggestions, showing interest in exploring alternatives. CH may volunteer counter proposals that invite others to evaluate his/her critique. May challenge content or procedural matters.	"I don't think you do it that way" "But wouldn't that mean abandoning the rest?"
Socially focused (SR)	Social roles are only coded when no other role can be derived. In other words, if someone provides content in a humorous manner it is still coded content provider.	
Harmonizer (HA)	Tries to have a positive effect on group atmosphere. May praise the group or member for good work. May resolve conflicts or use humor and jokes.	"Who's that Jason guy anyway?"
Disharmonizer (DH)	DH has a negative effect on group atmosphere. DH may make offensive or cynical comments or jokes that negatively influence the group.	"Nothing went well last sprint."
Undetermined roles		
Non-specified (NS)	NS is coded when utterances are inaudible or do not consist of any meaning. If someone thinks out loud ('uhhh') or is interrupted before anything comprehensible is said this is considered NS.	
Off-topic (OT)	When someone is talking on the phone or otherwise talking but not participating in the team meeting.	

2.4.2 Process mining

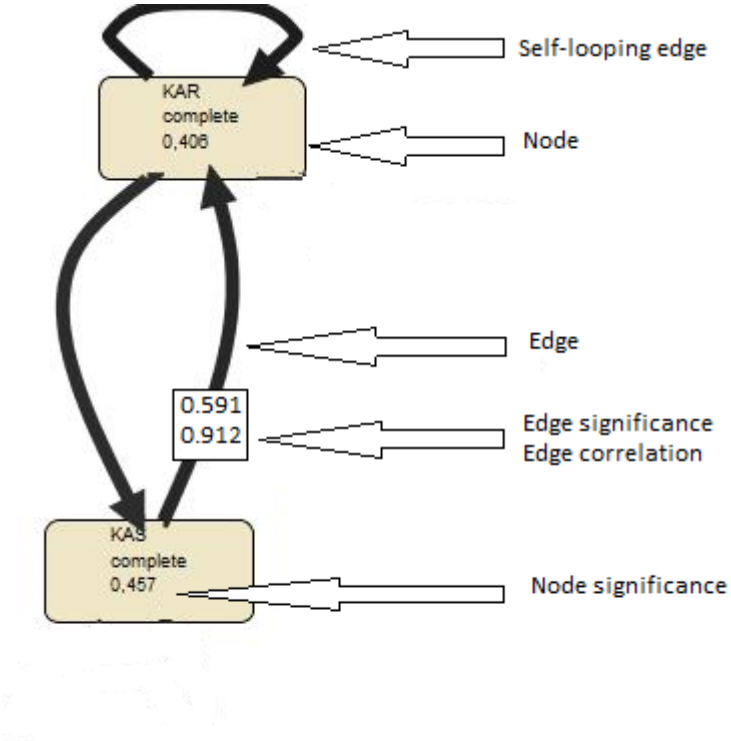
Regulation research has recently taken interest in a method of analysis called process mining (Sobocinski et al., 2017). Process mining is a method of making a comprehensive model of large amounts of data. It is mostly used in businesses, to analyze work processes and create comprehensive models that reduce inevitable noise present in large datasets. It was successfully used to analyze verbal communication with the goal of identifying self-regulated learning patterns (Schoor & Bannert, 2012; Reimann, Markauskaite & Bannert, 2014; Sobocinski et al., 2017). In this research, we will conduct fuzzy models (Günther & Aalst, 2007) on both regulation and roles. We intend to uncover sequential patterns found in these variables, and possibly distinguish between wrap-ups.

All wrap-up types will be examined on the existence of patterns regarding both roles and regulation phase and direction of activity. This will result in two process models per wrap type that can be analyzed and compared. The process mining tool that is used is Prom 6.8, developed by the University of Eindhoven. The mining tool that is used is the 'Fuzzy Miner' (Günther & Aalst, 2007; Bannert, Reimann & Sonnenberg; 2014). The output model will contain nodes (events, i.e. a role, or regulation instance) and edges (relation between nodes). The algorithm computes both significance and correlation of nodes and edges, while taking into account the temporal order of the events (i.e. what role follows on a previous role). The frequency of nodes and edges determines their significance, usually giving the most frequent node and the most frequent edge the value 1. For edges also correlation is calculated. This metric describes the strength of the relation between two nodes (co-occurrence).

A dummy model presented in Figure 1 shows the interaction between two individuals (coded KAR and KAS). In this case the individuals serve as the nodes in the model. The arrows connecting the nodes are called edges. The arrows pointing from one node to the other show how often and how strong these connections are. In the case of the dummy picture we see three edges. One connecting KAR with KAS and the other way around. Another arrow goes from KAR back to him. We call this a self-loop. The arrows indicate that in this conversation, sometimes KAS replies to KAR, and sometimes KAR replies to KAS. In other instances, KAR follows up on his own utterance.

Our analysis was conducted using the standard parameters (i.e. both unary and binary values at 1) (Günther & Aalst, 2007), while leaving all nodes and seemingly important edges in (node significance cutoff at 0; edge significance cutoff at 0.2, edge utility ratio at 0.75). In order to make models more comparable, the mean and standard deviation of edge significance values will be computed per model. This should allow for a more in depth analysis of the different networks.

Figure 1. Example of a fuzzy model and its components.



3. Results

The initial set of data consisted of a total of 387 episodes with 8116 utterances. Data consisted of 121 action, 145 cognitive, 90 no wrap-up and 31 no wrap-up needed episodes. The goal of this study is focused on regulation activities, and not on social talk or other off topic discourse. To increase reliability, it was decided to leave out the wrap-up type 'no wrap-up needed' from further analyses. This was done because the no wrap-up needed episodes consisted for a large amount of social talk (31,1%), were few in number (31) and the total amount of utterances in these episodes was low at only 495. A low frequency was also found for regulation directed at the organization of collaboration, with only 46 utterances. Including this regulation direction would greatly increase the degrees of freedom for the chi-square tests, hinder sequential analysis and thereby influence results. Disregarding no wrap-up needed episodes and organization directed codes left us with 356 episodes and a total of 7242 utterances. A description of the final data is found in Table 5.

In addition, a change to the definition of roles was necessary. While interpreting the results, the role disharmonizer was only found in 16 utterances, of which six were in the no wrap-up needed episodes and thus were disregarded. To increase reliability of role analyses, we decided to combine the harmonizer and disharmonizer roles into a more neutral role: the social role. Because it now consists of both positive and negative instances of socially focused interaction.

Table 5. *Description of utterances in the dataset*

	Action (121)	*Cognitive (145)*	*No-wrap (90)*	*Total (356)*
Cognition	975	951	592	2518 (34.5%)
Regulation	2068	2010	646	4724 (65.5%)
Total	3043	2961	1238	7242 (100%)
Phases				
Planning	1550	1106	250	2906 (61.5%)
Monitoring	396	568	229	1193 (25.3%)
Evaluation	122	336	167	625 (13.2%)
				4724 (100%)
Direction				
Project	1917	1851	515	4283 (90.7%)
Meeting	155	159	129	441 (9.3%)
				4724 (100%)

1. How do Scrum teams regulate their meetings and when is this done successfully?

In order to answer how Scrum teams regulate their meetings we will explore and describe what regulation activities are performed, what these are directed at and how they relate to each other. We found over 65% of all utterances to be regulation focused. About 35% is focused on cognition.

Focusing on the regulatory utterances we found significant differences in regulation activities and directions. The chi-square test yielded $\chi 2$ (2) = 847.227, $p < .000$. The most common regulation phase was that of planning (61.5%), followed by monitoring (25.3%). The evaluation phase was found the least at 13.2%. Regulation was most often directed at the project (90.7%). Meeting directed regulation occurred in 9.6% of the utterances. Post-hoc analysis using the Bonferroni-correction indicated several significant differences in regulation utterances. We found the planning and evaluation phase to be more often directed at the project than at the meeting. The monitoring phase is also more often directed at the project, but is significantly more often meeting directed than planning and evaluation. The data is available in Table 6.

Table 6. *Regulation phases and direction*

		Meeting	Project	Total
Planning	Count	55_a	2851_b	2906
	% within regulation direction	12.5%	66.6%	61.5%
	Adjusted Residual	-22.2	22.2	
Monitoring	Count	364_a	829_b	1193
	% within regulation direction	82.5%	19.4%	25.3%
	Adjusted Residual	29.1	-29.1	
Evaluation	Count	22_a	603_b	625
	% within regulation direction	5.0%	14.1%	13.2%
	Adjusted Residual	-5.4	5.4	
Total	Count	441	4283	4724
	% within regulation direction	100.0%	100.0%	100.0%

Note. Each subscript letter denotes a subset of regulation direction categories whose column proportions do not differ significantly from each other at the .05 level.

Table 7 shows the regulation phases differentiated among regulation directions, compared among the three wrap-up types. A chi-square test yielded $\chi 2$ (8) = 466,882, $p < .000$. This indicates an uneven distribution of regulation among wrap-ups. Post hoc analyses revealed a significant amount of planning directed at the project in action wrap-ups, compared to cognitive and no wrap-up episodes. No wrap-up episodes also show a smaller amount compared to cognitive wrap-ups. Monitoring of the project is found significantly more often

in cognitive episodes, and significantly less in action wrap-ups. No wrap-ups show an amount smaller than cognitive but larger than action wrap-ups. Evaluation of the project is found most often in no wrap-up episodes. These instances are less present in action wrap-ups. Cognitive wrap-ups show an amount that is more than action, but less than no wrap-up episodes. For planning and evaluation directed at the meeting, very few instances were discovered Monitoring of the meeting was found to have more instances. We found similar numbers for action and cognitive wrap-ups, these instances occurred significantly less often than in no wrap-up episodes.

Table 7. *Crosstab comparing regulation phases directed at project and meeting among wrap-ups.*

		Action	Cognitive	No wrap-up	Total
Planning (Project)	Count	1510_a	1094_b	243_c	2847
	% within wrap-ups	73.0%	54.4%	37.6%	60.3%
	Adjusted Residual	15.8	-7.1	-12.7	
Monitoring (Project)	Count	285_a	434_b	110_c	829
	% within wrap-ups	13.8%	21.6%	17.0%	17.5%
	Adjusted Residual	-6.0	6.3	-.4	
Evaluation (Project)	Count	118_a	323_b	162_c	603
	% within wrap-ups	5.7%	16.1%	25.1%	12.8%
	Adjusted Residual	-12.8	5.9	10.1	
Planning (Meeting)	Count	40_a	12_b	$7_{a.\ b}$	59
	% within wrap-ups	1.9%	0.6%	1.1%	1.2%
	Adjusted Residual	3.7	-3.5	-.4	
Monitoring (Meeting)	Count	111_a	134_a	119_b	364
	% within wrap-ups	5.4%	6.7%	18.4%	7.7%
	Adjusted Residual	-5.3	-2.3	11.0	
Evaluation (Meeting)	Count	4_a	13_b	5_b	22
	% within wrap-ups	0.2%	0.6%	0.8%	0.5%
	Adjusted Residual	-2.4	1.6	1.2	
Total	Count	2068	2010	646	4724
	% within wrap-ups	100.0%	100.0%	100.0%	100.0%

Note. Each subscript letter denotes a subset of wrap-up categories whose column proportions do not differ significantly from each other at the .05 level.

A fuzzy model of all regulation instances is presented in Figure 2. As could be expected viewing the frequencies, the most significant node is planning of the project. All other nodes are relatively much smaller in significance, as evaluation directed at the meeting is second with a significance of 0.769. However, the algorithm did not exclude any nodes, indicating that arcs connecting nodes may be of interest. Concentrating on the edges, we find high correlation values for nearly all arcs. This indicates that the connected nodes following each other are closely related and occur in a short time span. Significance of edges showed $M = 0.178$, $SD = 0.283$ with $N = 15$. For three self-looping edges we find very high significance values (significance value > $M + 1\ SD$, marked in red). These edges are found on planning project (1.000), evaluation project (0.559) and monitoring project (0.479). These highly significant self loops indicate that these regulation activities are often continued by other team members. The other edges show below average values ranging from 0.003 to 0.152.

Evaluation of the meeting stands out due to its high significance value (0.769) but insignificant self looping arc (0.017) and low frequency (22 utterances). An instance as this one may indicate importance in the process sequence. It seems that at this node, the process either ends, or continues to the evaluation project node. Other nodes seemingly important for the routing of the process are monitoring meeting, monitoring project and planning project, as these are all connected to four other nodes, implying a more central place in the process.

Figure 2. Fuzzy model displaying processes of regulation activities.

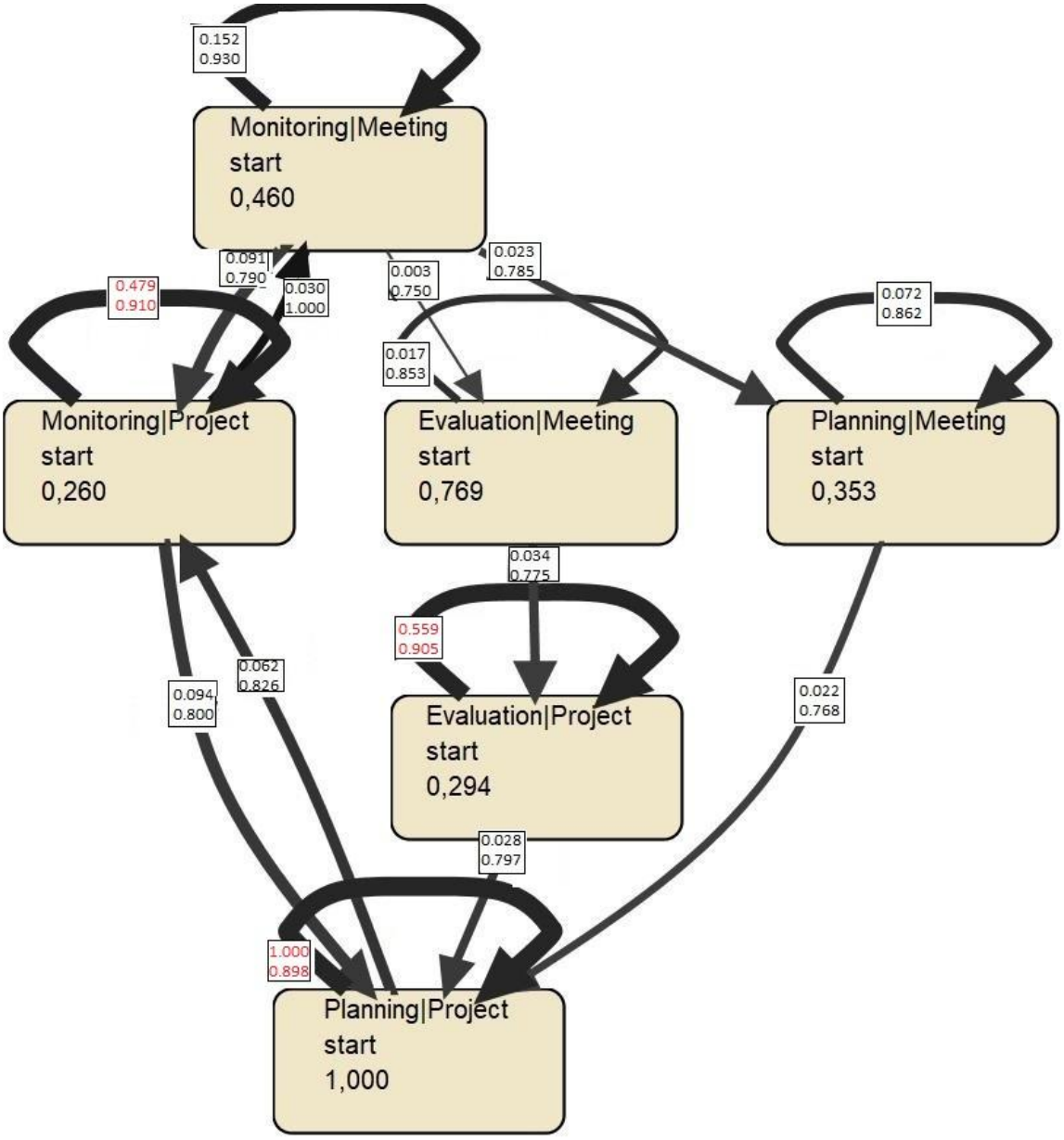


Figure 3 shows the same fuzzy models, but now differentiated on the different types of wrap-ups. As was the case in the global model, planning directed at the project has the largest significance value in all three models (1.000). In these models we also find very low significance and high correlation values for the edges. Self-loops are higher of significance than edges between nodes. Also in these models, no nodes were clustered together, suggesting that connections between nodes are of high enough value to be of interest.

Further, several differences were found. A clear difference between models is the significance of the nodes 'evaluation project' and 'evaluation meeting'. The significance of the first in the action model is low at 0.061, and high in the no wrap-up model (0.758). For planning meeting we find the opposite at 0.499 for action and 0.092 for no wrap-up, showing

that planning of the meeting is an important factor in the process to action wrap-ups, and evaluation of the project occurs more often in situations leading to no wrap-up.

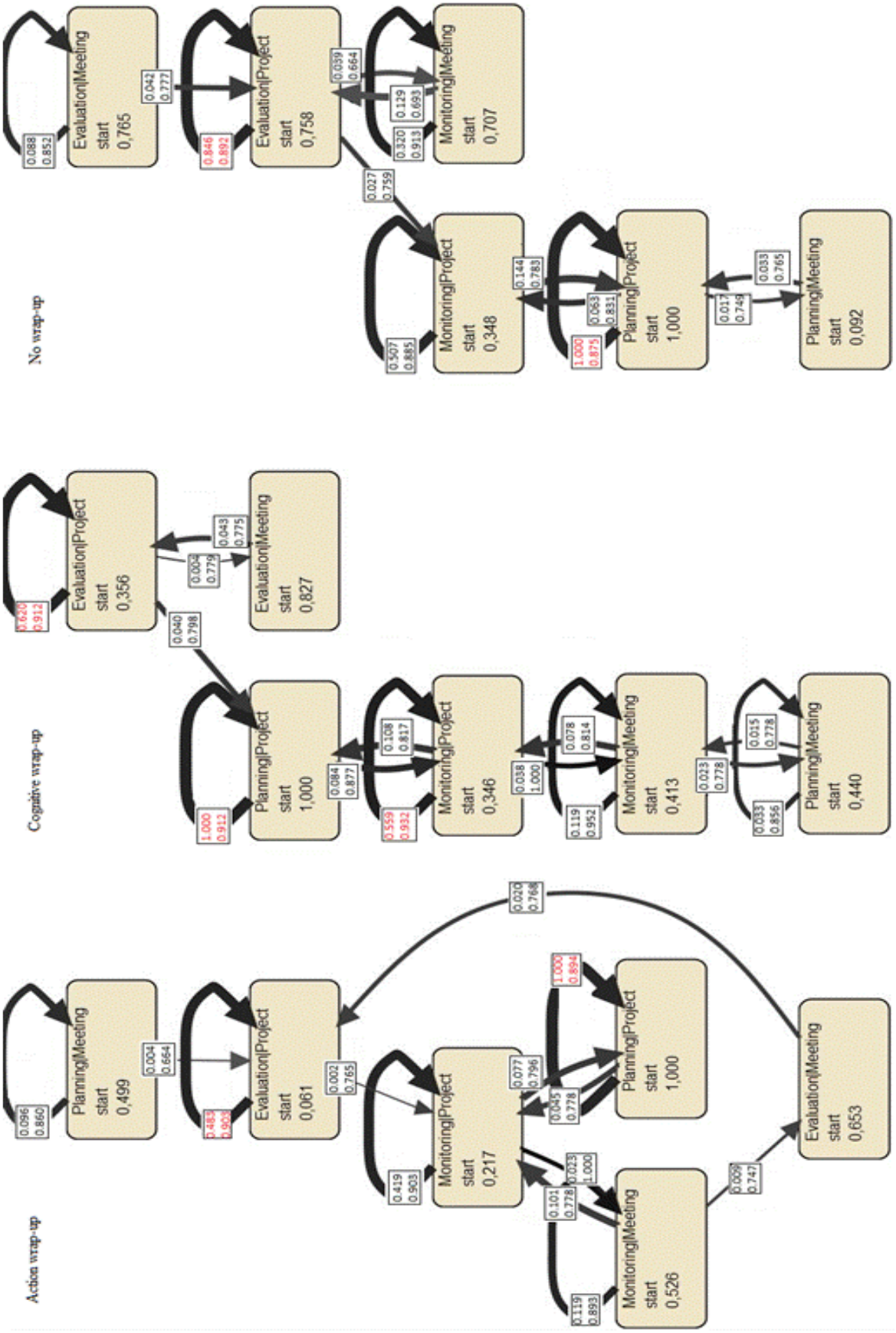
To make the models more comparable, we calculated the mean significance value and standard deviation for edges. Results are presented in table 8. As in the first fuzzy model, these models show standard deviations higher than their means. The highest mean is found for no wrap-ups, indicating that edge significance in this model is higher than in the other two. All models show a high significance (significance value > M + 1 SD) for self-loops on the nodes planning project and evaluation project. Monitoring project is also high in all three, but not above the significance mark. Other edges are all well below averages, with the exception of the self-looping edge on monitoring meeting (0.320) in the no wrap-up model. This may indicate that monitoring meeting regulation takes longer and is more often build on by different group members in no wrap-up instances.

Table 8. *Descriptive statistics on significance of edges of regulation models.*

	N	*M*	*SD*	*M + 1 SD*	Significant routes
Action wrap-up	13	.184	.290	0.474	**Planning project (SL)** [a]
					Evaluation project (SL) [b]
Cognitive wrap-up	14	.198	.304	0.502	**Planning project (SL)** [a]
					Evaluation project (SL) [b]
					Monitoring project (SL)
No wrap-up	13	.250	.331	0.581	**Planning project (SL)** [a]
					Evaluation project (SL) [b]

Note. Corresponding significant routes are marked in **bold**, each subscript letter denotes a corresponding route. SL = self loop

Figure 3. Fuzzy models on the action, cognitive and no wrap-up episodes, displaying regulation activities.



2. How are participatory roles played out in Scrum team meetings?

The distribution of participatory roles in all meetings and episodes is presented in Table 9. The most often occurring role was that of content provider, followed by the opinion giver. Least occurring were the supporter, opinion seeker, non-specified and social role.

Table 9. *Role frequency and percentage.*

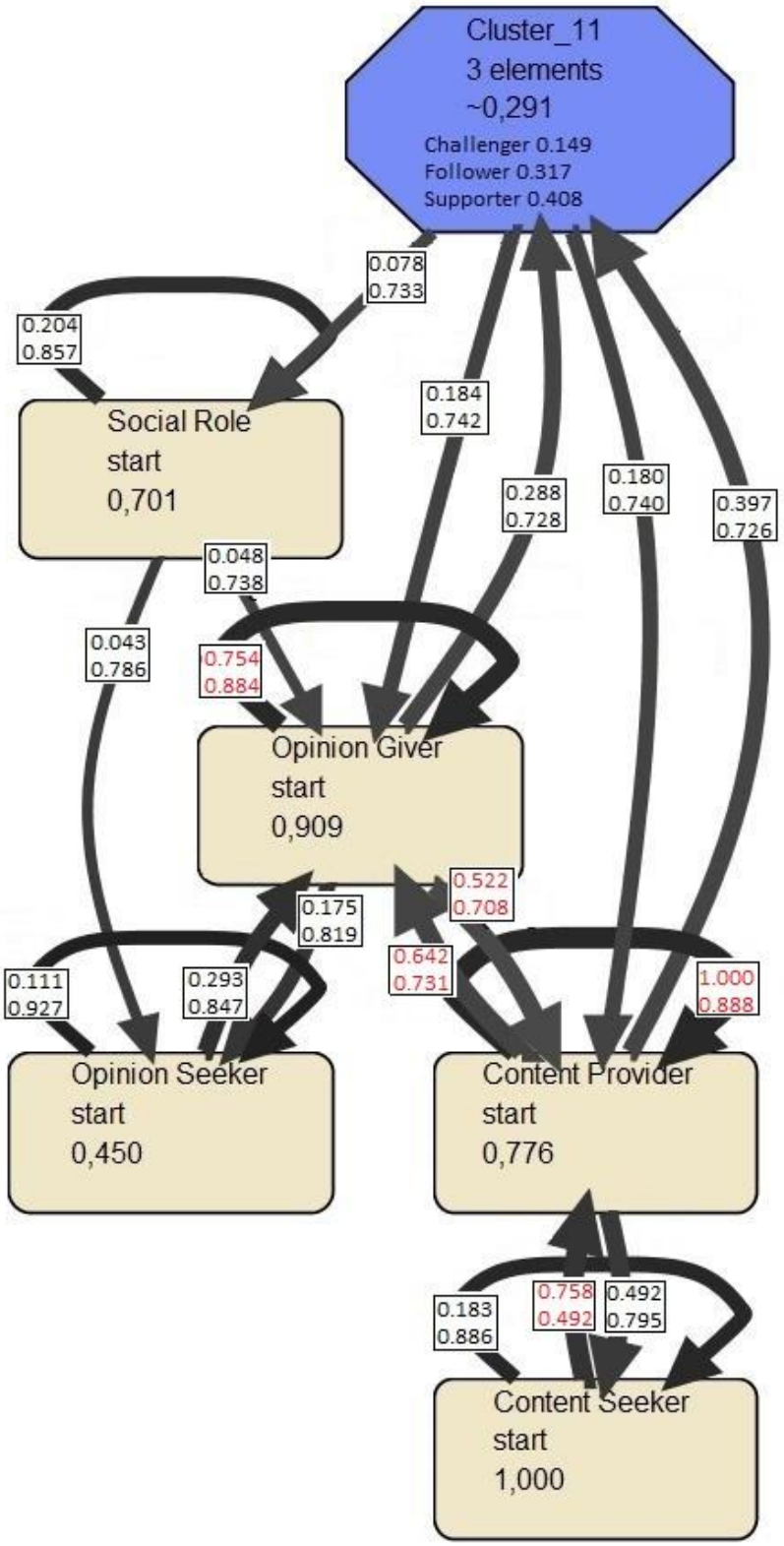
Roles	Frequency	Percent
Challenger	484	6.7
Content Provider	2453	33.9
Content Seeker	831	11.5
Follower	603	8.3
Non-specified	317	4.4
Opinion Giver	1763	24.3
Opinion Seeker	324	4.5
Social Role	107	1.5
Supporter	360	5.0
Total	7242	100.0

In order to find out whether there were differences in the adaptation of roles by team members the utterances were split based on the five different teams. For each of the five teams a chi-square test was conducted. It was chosen to do this within teams instead of on the whole dataset, as team members have different tasks within their team and team structures and procedures may vary. Due to some team members being passive or absent during meetings, several team members with little utterances to their name were removed from the analysis. Also the non-specified code was deleted from this specific analysis due to it causing empty cells in the chi-square test. As this is not a defined role, this is not perceived as problematic. The analysis resulted in five different *p*-values. All analyses yielded a *p*-value well below the significance mark of 0.05 ($p < 0.000$), indicating that the roles team members assume are not equally distributed. Some roles are found more often in certain team members, such as the opinion seeker and content provider. Detailed descriptions on the different teams are found in Tables 10-14 in appendix C. Persons who were assigned as Scrum Master (SM), showed a significantly high (>1.9) adjusted residual for the content seeker role in each team.

An analysis of the global fuzzy model on participatory roles displayed in Figure 4, was made to seek out any sequential patterns in roles. The first thing that stands out is the cluster, containing all evaluation focused roles: challenger, follower and supporter. Clusters in a fuzzy model indicate close relations and similarities of edges and nodes. These three roles have similar connections with the bridging nodes content provider, opinion giver and to a lesser extent social role. The non-specified model, while included in the analysis, is not present in the model. Meaning that it was insignificant even at our cutoff value of 0. The most significant roles overall are the content seeker and opinion giver. But also the content provider has a central position, with six connecting edges. Remarkable is the fact that the content seeker is the most significant (1.000), while its occurrence is only 11.5%. This can be explained by routing significance, indicating that sequentially following nodes (predecessors) are high in number and significance. These nodes indicate an important role in the process at which it either forks or merges (e. g. different paths can be taken). The model shows that the content seeker is followed by the content provider. Arcs in both ways between these nodes show high significance values, indicating that these roles often follow one another.

Overall mean edge significance was found to be 0.261, with a standard deviation of 0.243. Self looping arcs are present in this model as well and their significance value is high (significance value > M + 1 SD) for the opinion giver (0.754) and content provider (1.000). Other self loops seem to be less important, showing values close to the mean edge significance value. The model shows a fair amount of reciprocal connections between nodes, indicating that two roles may follow each other in different orders. For example, the content seeker is most often followed by the content provider, but a content provider may also trigger a content seeker response. Evaluation focused roles (cluster 11) are often assumed after either a content provider or opinion giver instance, and may in turn provoke instances of the opinion giver, content provider or in some instances social role.

Figure 4. Fuzzy model displaying participatory roles.



3. How do participatory roles contribute to successful regulation of team meetings?

Comparing utterances focused on regulation with utterances on cognition, disregarding social talk led to the results presented in Table 15. A chi-square test yielded $\chi 2$ (8) = 246.373, p < .000. This indicated that roles were not equally distributed among regulation and non-regulation utterances. A Bonferroni test showed multiple differences between in and outside regulation utterances. Regulation was characterized by significantly more by the performance focused roles: opinion giver and opinion seeker. Significantly less of the content provider, content seeker, social and non-specified role was observed in regulation. Roles that did not differ significantly were found to be the evaluation focused roles: challenger, supporter and follower.

A crosstab on participatory roles compared to regulation phases is presented in Table 16. Chi-square test yielded $\chi 2$ (16) = 278.581, p < .000, which indicates differences in distribution of roles within phases. Very few instances of the social role (42) were found within regulation. The Bonferroni correction and an analysis according to Beasley and Schumacker (1995) were used as post hoc analyses and show several significant findings. The evaluation phase is characterized by significant amounts of the roles opinion giver and social role. The evaluation phase was found to have less of the content provider, content seeker and opinion seeker role. For the monitoring phase, we found high numbers in content provider, content seeker, and the social role. Significantly small frequencies were found for the challenger and opinion giver role. The planning phase consisted of many adoptions of the challenger and opinion giver role. The presence of the content provider, content seeker and social role was limited.

Table 15. *Crosstab showing roles compared between regulation and cognition utterances.*

		Cognition	Regulation	Total
Challenger	Count	177_a	307_a	484
	% within utterances	7.0%	6.5%	6.7%
	Adjusted Residual	.9	-.9	
Content Provider	Count	967_a	1486_b	2453
	% within utterances	38.4%	31.5%	33.9%
	Adjusted Residual	**5.9**	**-5.9**	
Content Seeker	Count	316_a	515_b	831
	% within utterances	12.5%	10.9%	11.5%
	Adjusted Residual	**2.1**	**-2.1**	
Follower	Count	200_a	403_a	603
	% within utterances	7.9%	8.5%	8.3%
	Adjusted Residual	-.9	.9	
Non-specified	Count	174_a	143_b	317
	% within utterances	6.9%	3.0%	4.4%
	Adjusted Residual	**7.7**	**-7.7**	
Opinion Giver	Count	429_a	1334_b	1763
	% within utterances	17.0%	28.2%	24.3%
	Adjusted Residual	**-10.6**	**10.6**	
Opinion Seeker	Count	56_a	268_b	324
	% within utterances	2.2%	5.7%	4.5%
	Adjusted Residual	**-6.8**	**6.8**	
Social Role	Count	65_a	42_b	107
	% within utterances	2.6%	0.9%	1.5%
	Adjusted Residual	**5.7**	**-5.7**	
Supporter	Count	134_a	226_a	360
	% within utterances	5.3%	4.8%	5.0%
	Adjusted Residual	1.0	-1.0	
Total	Count	2518	4724	7242
	% within utterances	100.0%	100.0%	100.0%

Note. Using post hoc testing according to Beasley and Schumacker (1995) adjusted residuals in **bold** are significant cells. Each subscript letter denotes a subset of utterance categories whose column proportions do not differ significantly from each other at the .05 level.

Table 16. *Crosstab showing participatory role frequency in regulation phases.*

		Evaluation	Monitoring	Planning	Total
Challenger	Count	52_{a}	42_{b}	213_{a}	307
	% within RegulationPhase	8.3%	3.5%	7.3%	6.5%
	Adjusted Residual	2.0	**-4.8**	**2.9**	
Content Provider	Count	167_{a}	487_{b}	832_{a}	1486
	% within RegulationPhase	26.7%	40.8%	28.6%	31.5%
	Adjusted Residual	**-2.7**	**8.1**	**-5.3**	
Content Seeker	Count	55_{a}	202_{b}	258_{a}	515
	% within RegulationPhase	8.8%	16.9%	8.9%	10.9%
	Adjusted Residual	-1.8	**7.7**	**-5.6**	
Follower	Count	47_{a}	102_{a}	254_{a}	403
	% within RegulationPhase	7.5%	8.5%	8.7%	8.5%
	Adjusted Residual	-1.0	.0	.7	
Non-specified	Count	$16_{a.\,b}$	48_{b}	79_{a}	143
	% within RegulationPhase	2.6%	4.0%	2.7%	3.0%
	Adjusted Residual	-.7	2.3	-1.6	
Opinion Giver	Count	234_{a}	177_{b}	923_{c}	1334
	% within RegulationPhase	37.4%	14.8%	31.8%	28.2%
	Adjusted Residual	**5.5**	**-11.9**	**6.8**	
Opinion Seeker	Count	18_{a}	80_{b}	170_{b}	268
	% within RegulationPhase	2.9%	6.7%	5.8%	5.7%
	Adjusted Residual	**-3.2**	1.8	.7	
Social Role	Count	12_{a}	18_{a}	12_{b}	42
	% within RegulationPhase	1.9%	1.5%	0.4%	0.9%
	Adjusted Residual	**2.9**	**2.6**	**-4.4**	
Supporter	Count	$24_{a.\,b}$	37_{b}	165_{a}	226
	% within RegulationPhase	3.8%	3.1%	5.7%	4.8%
	Adjusted Residual	-1.2	**-3.1**	**3.6**	
Total	Count	625	1193	2906	4724
	% within RegulationPhase	100.0%	100.0%	100.0%	100.0%

Note. Using post hoc testing according to Beasley and Schumacker (1995) adjusted residuals in **bold** are significant cells. Each subscript letter denotes a subset of RegulationPhase categories whose column proportions do not differ significantly from each other at the .05 level.

Table 17 presents all instances of roles found tabulated across the three types of wrap-ups. The chi-square test resulted in $\chi 2$ (16) = 109.460, $p < .000$, indicating a significant relationship between the roles and wrap-up types. Using the Bonferroni-correction and Beasley and Schumacker method, we identified several significant findings. For the roles challenger, content seeker, follower and opinion seeker no significant differences were found between the different kinds of wrap types. Episodes with an action wrap-up were characterized by a significantly larger appearance of the roles supporter and opinion giver. A significantly low amount of the content provider and social role was found for these episodes. Cognitive episodes were characterized by more of the content provider, and less of the opinion giver and supporter compared to the other wrap-up types. Episodes without a wrap-up show more occurrences of non-specified instances and the social role.

Table 17. *Crosstab with roles and wrap types. including observed frequencies. expected frequencies. percentages and adjusted residuals.*

		Action	Cognitive	No-wrap	Total
Challenger	Count	219_{a}	195_{a}	70_{a}	484
	% within wrap-ups	7.2%	6.6%	5.7%	6.7%
	Adjusted Residual	1.5	-.3	-1.6	
Content Provider	Count	977_{a}	1068_{b}	$408_{a.\ b}$	2453
	% within wrap-ups	32.1%	36.1%	33.0%	33.9%
	Adjusted Residual	**-2.7**	**3.3**	-.7	
Content Seeker	Count	333_{a}	360_{a}	138_{a}	831
	% within wrap-ups	10.9%	12.2%	11.1%	11.5%
	Adjusted Residual	-1.2	1.5	-.4	
Follower	Count	237_{a}	258_{a}	108_{a}	603
	% within wrap-ups	7.8%	8.7%	8.7%	8.3%
	Adjusted Residual	-1.4	1.0	.6	
Non-specified	Count	120_{a}	$130_{a.\ b}$	67_{b}	317
	% within wrap-ups	3.9%	4.4%	5.4%	4.4%
	Adjusted Residual	-1.5	.0	**2.0**	
Opinion Giver	Count	802_{a}	665_{b}	$296_{a.\ b}$	1763
	% within wrap-ups	26.4%	22.5%	23.9%	24.3%
	Adjusted Residual	**3.4**	**-3.1**	-.4	
Opinion Seeker	Count	142_{a}	133_{a}	49_{a}	324
	% within wrap-ups	4.7%	4.5%	4.0%	4.5%
	Adjusted Residual	.7	.1	-1.0	
Social Role	Count	27_{a}	30_{a}	50_{b}	107
	% within wrap-ups	0.9%	1.0%	4.0%	1.5%
	Adjusted Residual	**-3.5**	**-2.7**	**8.2**	
Supporter	Count	186_{a}	122_{b}	52_{b}	360
	% within wrap-ups	6.1%	4.1%	4.2%	5.0%
	Adjusted Residual	**3.8**	**-2.8**	-1.4	
Total	Count	3043	2961	1238	7242
	% within wrap-ups	100.0%	100.0%	100.0%	100.0%

Note. Using post hoc testing according to Beasley and Schumacker (1995) adjusted residuals in **bold** are significant cells . Each subscript letter denotes a subset of wrap-up categories whose column proportions do not differ significantly from each other at the .05 level.

In Figure 5, the fuzzy models displaying participatory roles discerned between wrap-up types are presented. In addition, we again calculated and compared the mean significance of connecting edges between models. Outcomes can be found in Table 18. The model on action wrap-ups (M = 0.337, SD = 0.267) shows highly significant nodes for the roles opinion giver, content seeker, content provider and social role. The social role has a low frequency, but apparently this role is an important factor in the process. Edges with strong significance values (significance value > M + 1 SD) are found for the self-loops on content provider and opinion giver. The routes content seeker to content provider and content provider to opinion giver also show high values. Furthermore, we find no clusters in this model, indicating that all roles are of enough interest to be presented individually.

For the cognitive model (M = 0.226, SD = 0.243), we found the same nodes to be of high significance as in the action model. These are content seeker, opinion giver and content provider. The social role has a much smaller significance value. This model consists of two clusters, the first one clustering the opinion giver, opinion seeker, non-specified and social role and the second one clustering the evaluation focused roles. Connecting edges show significance values well above average for reciprocal routes between the content seeker and the content provider. The edges connecting the content provider with cluster 11 are also above average. The self-loop on content provider is very strong, but that of opinion giver is much less significant (0.569) when compared to the action model (0.915). Other arcs show very low significance values, compared to the action model.

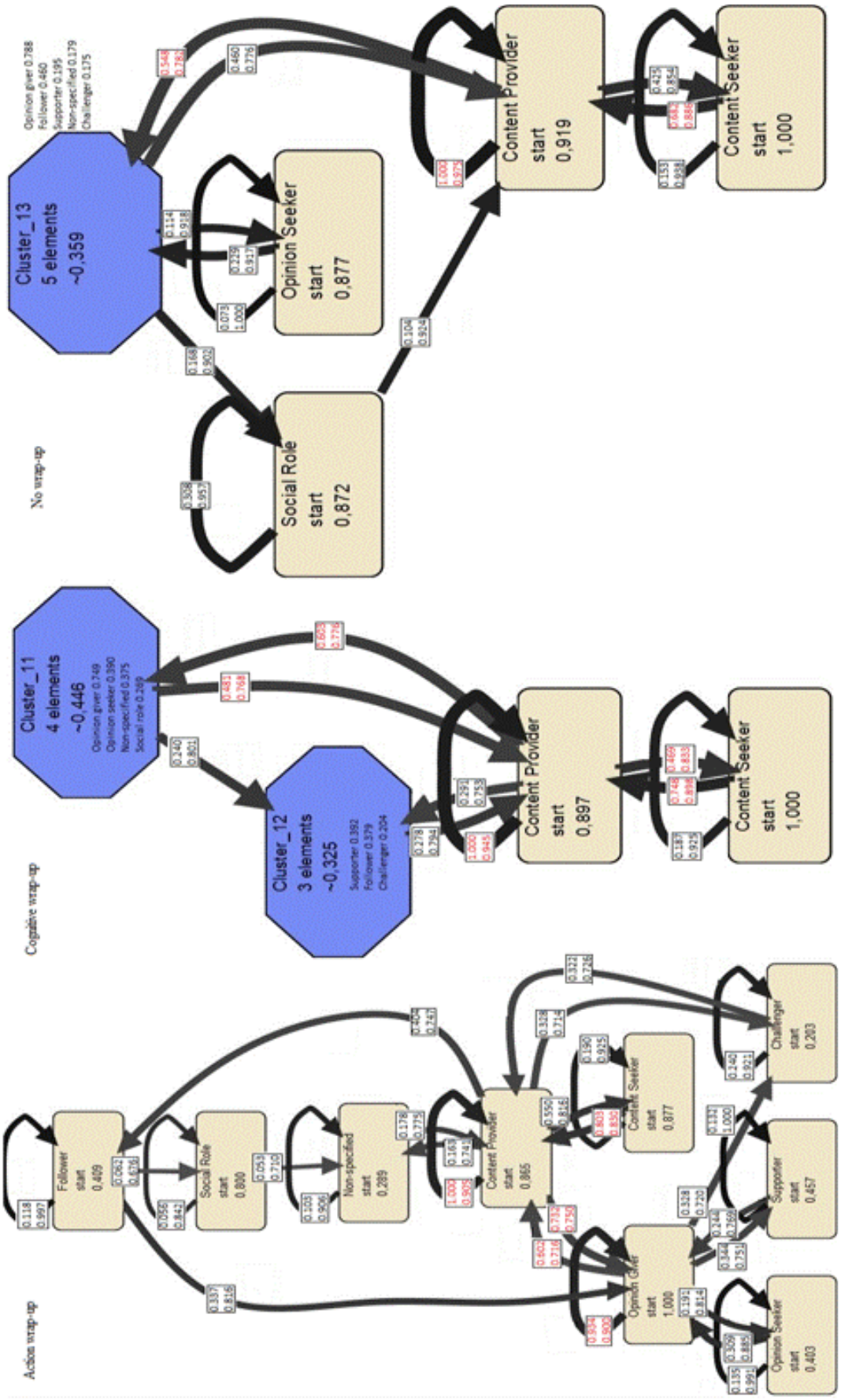
For the no wrap-up model (M = 0.266, SD = 0.240), we found a cluster containing five of nine roles. Nodes outside of the cluster are all show a significance value close to 1, indicating their importance to the model. Further, we see above average reciprocal edges from content seeker to content provider and from content provider to cluster 13. Other connecting edges show below average values.

Table 18. *Descriptive statistics on significance of edges of participatory role models.*

	N	*M*	*SD*	*M + 1 SD*	Significant routes
Action wrap-up	26	.337	.267	0.604	**Content provider (SL)** [a]
					Opinion giver (SL)
					Content provider to opinion giver
					Opinion giver to content provider
					Content seeker to content provider [b]
Cognitive wrap-up	25	.226	.243	0.469	**Content provider (SL)** [a]
					Content provider to content seeker
					Content seeker to content provider [b]
					Content provider to cluster_11
					Cluster_11 to content provider
No wrap-up	22	.266	.240	0.506	**Content provider (SL)** [a]
					Content provider to cluster_13
					Content seeker to content provider [b]

Note. Corresponding significant routes are marked in **bold**, each subscript letter denotes a corresponding route. SL = self loop.

Figure 5. Fuzzy models on the action, cognitive and no wrap-up episodes, displaying participatory roles.



4. Discussion

4.1 General discussion

The goal of this study was to explore the adoption and sequence of participatory roles in Scrum teams, with additional focus on regulation. Role analysis, regulation analysis and process mining were methods used to gain insight in sequence, distribution and patterns of participatory roles and regulation. Findings in this study bring to light several interesting insights on role assumption and regulatory activities in Scrum teams.

The first question was: "*How do Scrum teams regulate their meetings and when is this done successfully?*". Regulation activities were analyzed and compared using chi-square tests, and a fuzzy model was created to grant insight in the regulation of Scrum teams. To answer the question on successfulness we analyzed when regulatory activities and directions led to successful decision making (action or cognitive wrap-ups) or unsuccessful decision making (no wrap-ups). Based on the literature studied we would expect to find a varied pallet of regulation activities and directions. Especially in successful decision making we anticipate more and varied regulation activities, with perhaps an emphasis on the monitoring phase.

First, our findings show that most utterances in Scrum meetings are regulation oriented. Most of these regulation activities are directed at the project. Meeting directed regulation is more scarce, and organization directed regulation almost non-existent. Regulation phases are also unequally distributed, with the most common phase being planning, followed by monitoring, and lastly evaluation. This seems inconsistent with the expectations of a varied pallet of regulation activities. Especially regarding the regulation directions and the monitoring phase. The excessive amount of the planning phase, project oriented regulation and the non-existent organization directed regulation may indicate a difference between the school context found in literature and the Scrum context researched in this study. This discrepancy could be explained by the fact that Scrum teams do not work together during meetings, but rather organize and plan the labor that is to be done at a later stage. Further, Scrum meetings are highly organized and the focus of the meeting is mostly determined beforehand (Moe et al., 2010; Omar et al., 2018). Scrum meetings already show a cyclical nature, starting with planning, moving on to monitoring and then evaluating the work. This could mean that teams can focus explicitly on the project, as they do not need to focus on the organization of the meeting or collaboration, as this is already done beforehand.

The temporal nature of regulation in Scrum meetings, sought out by means of a Fuzzy model, shows several interesting findings. The first, and to our opinion most important finding, is that team members apparently build on each other's regulation activities. The strong self-loops we found for planning, monitoring and evaluation of the project indicate that utterances on these regulation activities are followed up by others. Shifting from one regulation phase to another within an episode rarely happened in our study. An explanation for this could again be the strict organization of Scrum, in which there are planning, stand-up, and review sessions, which seem to correspond with the evaluation phases of planning, monitoring and evaluation. As the scope of our research was the individual utterance level and not the character or outcome of certain Scrum meetings, we cannot be certain of this possible explanation.

Regarding the successfulness of decision making we found discrepancies. Successful decision making was characterized by more occurrences of the regulation activity planning of the project, and fewer occurrences of monitoring of the meeting when compared to unsuccessful decision making episodes. Planning of the project is needed to set the stage for focusing on important cognitive processes in school team settings (Rogat & Linnenbrink-Garcia, 2011). This could be parallel in the Scrum context we studied. Teams seem to use the opportunity of being together to plan labor ahead. It seems that when teams start to monitor the meeting instead of the project, decision making falters. This could simply be due to the fact that no decision has to be made about the meeting itself. It could also imply that the problems the team faces are too complex to solve immediately, and that they therefore fall into lower quality transactions and do not reach any decision at all (Rogat & Linnenbrink-Garcia, 2011). Regarding temporality, we found no evidence of striking differences between low and high quality decision making processes. In the studies on low versus high performing students, researchers found that high performing groups had a slightly more varied pallet of regulation activities, with more evaluation and planning (Malmberg et al., 2015; Schoor & Bannert, 2012). A possibility for this difference could be that decision making in Scrum is not the same as performance in a school setting.

The second question: "How are participatory roles played out in Scrum team meetings?" was answered by analyzing the frequencies, patterns and the relation between individuals and the roles they take on.

First, we did not find evidence of individuals assuming all roles equally, but rather that team members only adopt a couple of roles. Our results indicate that many roles are evenly spread among teams, but that some individuals play out certain roles more often than others. We found that some individuals in different groups had a preference for the opinion giver and content provider or content seeker. Interestingly, we found that the Scrum Master of each group displayed significantly more content seeker roles. This strengthens the findings by Volet et al. (2017), who found a similar flexible adoption of roles in student team work. Also in their study, some team members took on a lot of instances of a specific role. There could be multiple reasons for this, such as a team member experiencing uncertainty about a topic (which could lead to many follower or content seeker instances) or their character (having a serving nature could perhaps lead to opinion seeker or supporter instances), which could be studied in future research.

Overall the most often played out roles were the content provider and opinion giver. This is an interesting find, when taking into account that the 'asking' roles: content seeker and opinion seeker occur less often. It seems that when a team member 'asks' for content or an opinion, multiple others react to this and build on each other. By adding extra information or stating yet another opinion. Process mining analyses strengthen this hypothesis, by indeed showing that opinion givers and content providers are important and common, but also including the content seeker and opinion seeker as significant roles. The fact that the content seeker is seen as most significant despite its relatively low frequency may be explained by the fact that many episodes are started by an instance of this role. And that most following discourse is somehow connected to this apparently 'central' question this content seeker poses. The content seeker therefore seems to be a crucial role in Scrum team interaction, even though it is not the most occurring role.

The four significant roles have the tendency of following up one another and create a strong segment focused on performance and content. The connection of opinion giver to evaluation based roles is also logical, as stating an opinion or idea often leads to someone agreeing or disagreeing. Not very surprising is that some roles are followed up by another instance of that role. Social roles, content providers and opinion givers are often repeated by utterances using the same role. This is explained as someone reacting to an utterance on the same topic, engaging in and continuing the conversation. The roles that were clustered into

one category by the fuzzy model are also clustered as one group in the coding scheme. These evaluation focused roles are found to very similar in relation to other roles. This seems logical, as agreeing, being neutral or disagreeing with a comment are common reactions.

The research question "*How do participatory roles contribute to successful regulation of team meetings?*" lead to the exploration of participatory roles in regulation and in relation to wrap-ups.

Most importantly, we found episodes that differ in decision making quality to also differ in their role distribution. The supporter and opinion giver are of importance in action wrap-ups, in which teams find a concrete solution to a problem. In cognitive wrap-ups, where consent on understanding is reached, these roles are less significantly present in the process mining models. Here, the content provider is more significant. This makes the distinction between these kinds of episodes more plausible (Raes et al., 2015). Curiously, we found the opinion giver to be of great importance for effective decision making, while Volet et al. (2017) found content focused roles to occur more in high performing student groups. We believe that this divergence is again due to the different nature of the conversations between studies. Solutions in scrum meetings are often procedurally oriented, while in school settings these are often of a more cognitive and understanding nature (Tynjälä, 2008). A possible explanation is the fact that in school settings people often work on a project directly, while in a work place setting this is not the case. Another explanation, that has been stated before in this study, is that decision making and performance may not be directly comparable.

Ineffective decision making episodes show the most instances of the social role, while both cognitive and action wrap-ups show significantly less of this role. Rogat and Linnenbrink-Garcia (2011) found low quality interaction and regulation to lead to disengagement. The presence of social roles may indicate that team members lose focus and engage in discourse that is not topic related or of lower quality. Based on our results it is not clear if the social role is the cause of ineffective decision making or an outcome of low quality interaction.

Using process mining we discovered that effective decision making episodes show strong connections between the content provider, content seeker and opinion giver. Ineffective decision making episodes show higher significance values for the social role and the opinion seeker. This deviates from Volet et al. (2017), where the opinion seeker was found to be of value in high performing groups as a connecting factor and facilitator of social regulation. In our study, we did find similarities when looking at scrum masters: This is the person in a team

who is in charge of the course of the meeting. The scrum master was found to most often be the initiator of a new topic, often by assuming the opinion seeker or content seeker role. Perhaps the opinion seeker role is more evident in scrum meetings when the team is already struggling to come to an agreement, by trying to support and lead the team to a solution. The high significance of the social role in the fuzzy model underlines our previous findings, where we discussed that this role is a logical find in episodes that do not lead to a wrap-up. One could wonder if the appearance of the social role leads to no conclusion, or if it is the other way around. In which low quality of regulation instances lead to disengagement of team members (Rogat & Linnenbrink-Garcia, 2011).

Focusing on the relation between roles and regulation, we found that regulation was characterized by a different pallet of roles than utterances on cognition. Cognition based utterances were mostly content focused, with more instances of content seekers and providers. Regulation was found to be more performance focused, as individuals assumed the opinion giver and opinion seeker role more often. This is to be expected of shared regulation, as its core concept is the focus on managing work, time and mutual agreement (Lord, et al., 2010; Hadwin & Oshige, 2011; Schoor, et al., 2015).

Zooming in on regulation phases, we found the monitoring phase to often consist out of content provider and content seeker instances. This could be explained by the nature of the monitoring phase. In this phase, team members should often inform each other on their progress. This in turn may lead to people explaining their actions, and others asking them for more detailed information. The planning phase was characterized by a lot of challenger and opinion givers. Again, it is not difficult to explain this, considering the nature of the planning phase. Team members seem to focus mostly on giving an opinion on how they believe the project should proceed. Challenger roles may be a logical reaction to these opinion givers, by disagreeing, or stating flaws in proposed plans. The evaluation focused regulation consisted more of opinion giver utterances. These could be explained as team members stating their opinion on something regarding the project.

4.2 Limitations and future research

In this exploratory study we focused on the utterance and episode level of conversations in Scrum teams. Our data did not include any information on the cohesion and task division of teams, nor the performance of different teams. We also did not include any individual characteristics of team members. Analyzing regulation on the utterance level does not take complex factors at play in team processes into account. The same is true for the different meetings Scrum teams have, as these meetings are of different natures and thus may have required a different set of roles for successful decision making. This implies a gap, as teams have a history of communicating and working together, which indicates latent routines and relations. Of course, our data cannot be generalized beyond Scrum teams.

Another method of assessing performance in Scrum teams could also lead to different results and pallets of role distribution. While the use of wrap-ups proved to be an interesting method of discerning in performance quality, it is not perfect. Future studies could perhaps inventory how team members rate the effectiveness of their meetings using diaries. The actual team output could be assessed by managers and product owners.

Further, sequential analysis using process mining is still in its infancy. Parameters are very plentiful and different settings may lead to different outcomes on the same data. Advanced understanding of the method is not yet available (Bannert et al. 2014). Further, process mining analysis entails that a predetermined theoretical model is used for the coding of events. And thus, may not match with reality if the model is faulty to begin with, making temporal analysis a challenging endeavor (Reimann et al., 2014; Molenaar & Järvalä, 2014). This also limits the comparability of sequential analysis studies, as many of these use (slightly) different regulatory activities (Bannert et al., 2014).

Future studies should therefore focus on the further exploration of process mining methods. The influence of parameters needs to be understood further in order to enhance the reliability and validity of process mining methods. Next, exploring existing abstract theories in social science using this method may bring new insights and may further strengthen or even weaken such theories. Another suggestion we would like to make is researching both team and individual characteristics. Understanding how these influence teams and individuals and whether different role distributions occur is yet unknown but may provide important insights. Further, studies on participatory roles may focus on the different scrum roles (product owner, scrum master), and outside agile, to explore further supportive insights on team performance.

4.3 Practical implications and conclusion

The findings of this study bring new understanding towards the new theoretical concept of participatory roles. This study contributed by a unique exploration of Scrum utilizing sequential analysis of both regulatory activities and participatory roles. While scrum teams are expected to self manage, this does not always work. Implementation should be closely supervised and support should be readily available to help teams choose the right regulation strategies and roles. Educating scrum teams on regulation and participatory roles could help them to better performance, as individuals learn to identify the adoption of ineffective roles in particular situations and may steer themselves and team members accordingly.

To conclude, this study provided knowledge on both the sequential and relative frequency order in which participatory roles and regulation occur in Scrum meetings. Consolidated evidence was found for the existence and patterns of participatory roles in Scrum. Beneficial and detrimental effects of roles were also found with regards to team co-construction and regulation.

5. References

Acuña, S. T., Gómez, M., & Juristo, N. (2009). How do personality, team processes and task characteristics relate to job satisfaction and software quality?. *Information and Software Technology*, *51*(3), 627-639.

Bannert, M., Reimann, P., & Sonnenberg, C. (2014). Process mining techniques for analysing patterns and strategies in students' self-regulated learning. *Metacognition and learning*, *9*(2), 161-185.

Beasley, T. M., & Schumacker, R. E. (1995). Multiple regression approach to analyzing contingency tables: Post hoc and planned comparison procedures. *The Journal of Experimental Education*, *64*(1), 79-93.

Benne, K. D., & Sheats, P. (2007). Functional roles of group members. *Group Facilitation, 8,*30–35 (re-printed).

Bron, R., Endedijk, M.D., Erkens, G., & Veldkamp, B.P. (2019). *Untangling interactional patterns underlying team learning: A sequential analysis*. Manuscript submitted for publication.

Chiu, M. M. (2000). Group problem-solving processes: Social interactions and individual actions. *Journal for the Theory of Social Behaviour*, *30*(1), 26–49.

De Dreu, C. K., & Weingart, L. R. (2003). Task versus relationship conflict, team performance, and team member satisfaction: a meta-analysis. *Journal of applied Psychology*, *88*(4), 741.

Decuyper, S., Dochy, F., & van den Bossche, P. (2010). Grasping the dynamic complexity of team learning: An integrative model for effective team learning in organisations. *Educational Research Review*, *5*(2), 111-133.

DeShon, R. P., Kozlowski, S. W., Schmidt, A. M., Milner, K. R., & Wiechmann, D. (2004). A multiple-goal, multilevel model of feedback effects on the regulation of individual and team performance. *Journal of applied psychology*, *89*(6), 1035-1056.

Duffy, M. C., Azevedo, R., Sun, N., Griscom, S. E., Stead, V., Crelinstein, L., Wiseman, J., Maniatis, T., & Lachapelle, K. (2014). Team regulation in a simulated medical

emergency: An in-depth analysis of cognitive, metacognitive, and affective processes. *Instructional science, 43*, 401-426.

Dybå, T., & Dingsøyr, T. (2008). Empirical studies of agile software development: A systematic review. *Information and software technology*, *50*(9), 833-859.

Edmondson, A.C. (1999), "A model of work-team learning. Psychological safety and learning behaviour in work teams", *Administrative Science Quarterly*, *44*(2), pp. 350-383.

Edmondson, A. C., Dillon, J. R., & Roloff, K. S. (2007). Three perspectives on team learning: outcome improvement, task Mastery, and group process. *The academy of management annals*, *1*(1), 269-314.

Günther, C. W., & Aalst, van der, W. M. P. (2007). Fuzzy mining - adaptive process simplification based on multi-perspective metrics. In G. Alonso, P. Dadam, & M. Rosemann (Eds.), *Proceedings of the 5th International Conference on Business Process Management (BPM 2007) 24-28 September 2007, Brisbane, Australia* (pp. 328-343). (Lecture Notes in Computer Science; Vol. 4714). Berlin: Springer.

Grau, V., & Whitebread, D. (2012). Self and social regulation of learning during collaborative activities in the classroom: The interplay of individual and group cognition. *Learning and Instruction*, *22*(6), 401-412.

Hadwin, A., & Oshige, M. (2011). Self-regulation, coregulation, and socially shared regulation: Exploring perspectives of social in self-regulated learning theory. *Teachers College Record*, *113*(2), 240-264.

Lord, R. G., Diefendorff, J. M., Schimdt, A. M., & Hall, R. J., (2010). Self-regulation at work. *Annual Review of Psychology, 61*, 543-568.

Malmberg, J., Järvelä, S., Järvenoja, H., & Panadero, E. (2015). Promoting socially shared regulation of learning in CSCL: Progress of socially shared regulation among high-and low-performing groups. *Computers in Human Behavior, 52*, 562-572.

Moe, N. B., Dingsøyr, T., & Dybå, T. (2008). *Understanding self-organizing teams in agile software development.* Paper presented at the 19th Australian Conference on Software Engineering, 2008. ASWEC 2008.

Moe, N. B., Dingsøyr, T., & Dybå, T. (2010). A teamwork model for understanding an agile team: A case study of a Scrum project. *Information and Software Technology, 52*(5), 480-491.

Molenaar, I., & Järvalä, S. (2014). Sequential and temporal characteristics of self and socially regulated learning. *Metacognition learning, 9*, 75-85.

Omar, M., Khasasi, N. L. A., Abdullah, N. L. H., Romli, R., & Katuk, N. (2018). Defining skill sets requirements for agile Scrum team formation. *Journal of Engineering and Applied Science, 13*(3), 784-789.

Pintrich, P. R. (2000). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *Journal of educational psychology, 92*(3), 544-555.

Poole, M. S., & Roth, J. (1989). Decision development in small groups IV: A typology of group decision paths. *Human Communication Research, 15*(3), 323-356.

Raes, E., Boon, A., Kyndt, E., & Dochy, F. (2013). Team learning beliefs and behaviours in response teams. *European Journal of Training and Development, 37*(4), 357-379.

Reimann, P., Frerejean, J., & Thompson, K. (2009, June). Using process mining to identify models of group decision making in chat data. In *Proceedings of the 9th international conference on Computer supported collaborative learning-Volume 1* (pp. 98-107). International Society of the Learning Sciences.

Rising, L. and Janoff, N.S. (2000). The Scrum Software Development Process for Small Teams. *IEEE Software, 17*, 26- 32.

Rogat, T. K., & Linnenbrink-Garcia, L. (2011). Socially shared regulation in collaborative groups: An analysis of the interplay between quality of social regulation and group processes. *Cognition and Instruction, 29*(4), 375-415.

Rousseau, V., & Aubé, C. (2010). Social Support at Work and Affective Commitment to the Organization: The Moderating Effect of Job Resource Adequacy and Ambient Conditions. *The Journal of Social Psychology, 150*, 321-340.

Schoor, C., & Bannert, M. (2012). Exploring regulatory processes during a computer-supported collaborative learning task using process mining. *Computers in Human Behavior*, *28*(4), 1321-1331.

Schoor, C., Narciss, S., & Körndle, H. (2015). Regulation during cooperative and collaborative learning: A theory-based review of terms and concepts. *Educational Psychologist*, *50*(2). 97-119.

Sobocinski, M., Malmberg, J. & Järvelä, S. (2017). Exploring temporal sequences of regulatory phases and associated interactions in low- and high-challenge collaborative learning sessions. *Metacognition Learning, 12*(2), 275–294.

Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review, 3*(2), 130- 154.

Van den Bossche, P., Gijselaers, W.H., Segers, M. & Kirschner, P.A. (2006). Social and cognitive factors driving teamwork in collaborative learning environments: team learning beliefs and behaviors", *Small Group Research, 37* (5), pp. 490-521.

Van der Haar, S., Wijenberg, B., Van den Bossche, P. and Segers, M. (2013), "Team learning behavior: a study in the setting of command and control teams", paper presented at the 15the Biennial Conference Earli 2013, Munich.

Volet, S. E., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained? *Learning and Instruction, 19*(2), 128–143.

Volet, S., Vauras, M., Salo, A., & Khosa, D. (2017) Individual contributions in student-led collaborative learning: Insights from two analytical approaches to explain the quality of group outcome. *Learning and Individual Differences, 53*, 79–92.

Wijga, M., Endedijk, M. D., (2016). Towards a New Integrative Framework To Capture Self- and Social Regulation at the Workplace.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational psychologist*, *25*(1), 3-17.

Appendix A: Coding Scheme on regulation

Code	Definition	Example
Wrap ups	Every episode is coded with a wrap-up. This is a plan for subsequent action, a conclusion of an agreement, or the summary of a solution.	
Cognitive wrap-up	A cognitive wrap-up occurs when consensus is reached on the understanding of information, theory, or planning. When the team decides to postpone a decision, this is also considered a cognitive wrap-up.	"So, we will give this sprint five points." "Okay, so we will see later on"
Action wrap-up	An action wrap-up is coded when subsequent action is planned after a discussion or conflict.	"Shall we then each prepare some questions before next week?" "So we agree: We will split into much smaller stories."
No wrap	No consent is reached within the team and they move on to another topic without any decision making or agreement.	
No wrap needed	Only coded if there is no wrap-up and the topic clearly does not require one.	
Regulation utterances		
Regulation	Intentional and goal directed group efforts to regulate its conceptual understanding and task work. Collectively shared regulatory processes orchestrated in the service of shared outcome.	
Cognition	Utterances about the content of the task and the elaboration of this content.	I can't log into the new user interface.
Off-topic	When communication is too hard to understand or the sound is unclear.	
Social talk	Talk not aimed at regulating the project and the team processes.	I'm playing the wild card now.

Regulation phases	
Planning	Discussing how to go about solving problems, discussing strategies, goal setting, collaboratively discussing task directions, translating directions into a clear plan, designating tasks.
Monitoring	Checking progress and comprehension of the task (I do not understand, you are doing it wrong). Comparing a current state with a desired state (goal standard). Monitoring content understanding, assessing progress, recognizing what remains to be completed, monitoring the pace and time remaining.
Evaluation	Making a judgment about goal attainment. Or discussing what could be improved next time.
Direction of activity	
Project	Regulation directed to planning, monitoring or evaluation of the design processes. Regulation activities on the content of the project.
Meeting	Regulation activities directed at the practical organization and logistics of the meeting.
Organization	Regulation activities directed at the practical organization and logistics of the collaboration process.

Appendix B: Coding scheme on roles

Code	Definition	Example
Content focused (CF)	Content focused roles focus on information, facts and knowledge.	
Content seeker	Seeks for facts, information or knowledge related to content. May ask questions to deepen own understanding or may invite others to speak about content.	"How does that work?" "What did you do?" "Can you say something about that?"
Content provider	CP offers facts, information or knowledge on content. Can also be in question form, when seeking confirmation.	"We did this and that, right?" "I checked to see if X works the other way around too"
Performance focused (PF)	Procedure focused roles express opinions on procedural matters.	
Opinion seeker (OS)	Invites others to express their opinions in something dominantly related to procedures. OS may want to know which alternative should be chosen, or how the team should proceed or initiate a new procedural approach.	"What do you think we should do? " "Is it possible to do it like this?" "What do we do with definitions?"
Opinion giver (OG)	OG expresses an opinion. For example, by telling which solution, alternative or approach the group should choose. Can be in question form when seeking confirmation. May also evaluate previous procedures, stating what he thought worked well. OG may also state brief opinions as 'it will probably work out anyway'. OG does not challenge someone else's opinion or criticizes, like challenger does..	"We should try to do that first." "Don't you think we should try X?" "I would advise to do X, because..."
Evaluation focused (EF)	Evaluation focused roles react to previous statements.	
Follower (FO)	Either agrees or is indifferent with suggestions made or information provided in a short sentence. FO is only coded when one is not just listening actively (humming, nodding, or saying yes while other is talking), but explicitly replying to a previous comment. This can be just acknowledging or replying doubtingly.	"I see." "Oh, okay." "Right."

Supporter (SU)	SU clearly agrees with previous statement. May state supported statement in other words to further clarify or present short supportive additions or proposals. SU only supports comments of other team members.	"Yes, finish the screen first." "Exactly!"
Challenger (CH)	Puts previous comments to the test by asking for clarification or disagreeing with suggestions, showing interest in exploring alternatives. CH may volunteer counter proposals that invite others to evaluate his/her critique. May challenge content or procedural matters.	"I don't think you do it that way" "But wouldn't that mean abandoning the rest?"
Socially focused (SR)	Social roles are only coded when no other role can be derived. In other words, if someone provides content in a humorous manner it is still coded content provider.	
Harmonizer (HA)	Tries to have a positive effect on group atmosphere. May praise the group or member for good work. May resolve conflicts or use humor and jokes.	"Who's that Jason guy anyway?"
Disharmonizer (DH)	DH has a negative effect on group atmosphere. DH may make offensive or cynical comments or jokes that negatively influence the group.	"Nothing went well last sprint."
Undetermined roles		
Non-specified (NS)	NS is coded when utterances are inaudible or do not consist of any meaning. If someone thinks out loud ('uhhh') or is interrupted before anything comprehensible is said this is considered NS.	
Off-topic (OT)	When someone is talking on the phone or otherwise talking but not participating in the team meeting.	

Appendix C: Tables

Table 10. *Participatory role distribution among subjects in team 1.*

		BBK	BFM	BFV	BPB (SM)	Total
Challenger	Count	48	12	20	22	102
	Expected Count	27.6	8.4	17.4	48.6	102.0
	% within Subject	13.8%	11.3%	9.1%	3.6%	7.9%
	Adjusted Residual	4.7	1.4	.7	-5.5	
Content Provider	Count	100	42	58	195	395
	Expected Count	106.7	32.5	67.5	188.3	395.0
	% within Subject	28.7%	39.6%	26.4%	31.8%	30.7%
	Adjusted Residual	-.9	2.1	-1.5	.8	
Content Seeker	Count	47	9	20	98	174
	Expected Count	47.0	14.3	29.7	82.9	174.0
	% within Subject	13.5%	8.5%	9.1%	16.0%	13.5%
	Adjusted Residual	.0	-1.6	-2.1	2.5	
Follower	Count	31	14	13	55	113
	Expected Count	30.5	9.3	19.3	53.9	113.0
	% within Subject	8.9%	13.2%	5.9%	9.0%	8.8%
	Adjusted Residual	.1	1.7	-1.6	.2	
Opinion Giver	Count	90	22	78	149	339
	Expected Count	91.6	27.9	57.9	161.6	339.0
	% within Subject	25.9%	20.8%	35.5%	24.3%	26.3%
	Adjusted Residual	-.2	-1.4	3.4	-1.6	
Opinion Seeker	Count	7	1	5	44	57
	Expected Count	15.4	4.7	9.7	27.2	57.0
	% within Subject	2.0%	0.9%	2.3%	7.2%	4.4%
	Adjusted Residual	-2.6	-1.8	-1.7	4.6	
Social Role	Count	9	1	14	17	41
	Expected Count	11.1	3.4	7.0	19.5	41.0
	% within Subject	2.6%	0.9%	6.4%	2.8%	3.2%
	Adjusted Residual	-.7	-1.4	3.0	-.8	
Supporter	Count	16	5	12	34	67
	Expected Count	18.1	5.5	11.4	31.9	67.0
	% within Subject	4.6%	4.7%	5.5%	5.5%	5.2%
	Adjusted Residual	-.6	-.2	.2	.5	
Total	Count	348	106	220	614	1288
	Expected Count	348.0	106.0	220.0	614.0	1288.0
	% within Subject	100.0%	100.0%	100.0%	100.0%	100.0%

Table 11. *Participatory role distribution among subjects in team 2.*

		IET	IJR	IMV	IPO J	IPO2 R	ISW (SM)	Total
Challenger	Count	23	8	30	23	11	69	164
	Expected Count	28.0	17.5	25.5	26.5	8.2	58.3	164.0
	% within Subject	5.8%	3.2%	8.3%	6.1%	9.5%	8.4%	7.1%
	Adjusted Residual	-1.1	-2.5	1.0	-.8	1.0	1.8	
Content Provider	Count	160	72	127	181	46	250	836
	Expected Count	142.9	89.2	129.9	135.0	41.9	297.1	836.0
	% within Subject	40.4%	29.1%	35.3%	48.4%	39.7%	30.4%	36.1%
	Adjusted Residual	2.0	-2.4	-.4	5.4	.8	-4.3	
Content Seeker	Count	20	48	55	17	13	133	286
	Expected Count	48.9	30.5	44.5	46.2	14.3	101.6	286.0
	% within Subject	5.1%	19.4%	15.3%	4.5%	11.2%	16.2%	12.3%
	Adjusted Residual	-4.8	3.6	1.8	-5.0	-.4	4.1	
Follower	Count	17	24	27	32	5	57	162
	Expected Count	27.7	17.3	25.2	26.2	8.1	57.6	162.0
	% within Subject	4.3%	9.7%	7.5%	8.6%	4.3%	6.9%	7.0%
	Adjusted Residual	-2.3	1.8	.4	1.3	-1.2	-.1	
Opinion Giver	Count	138	63	91	76	33	202	603
	Expected Count	103.1	64.3	93.7	97.4	30.2	214.3	603.0
	% within Subject	34.8%	25.5%	25.3%	20.3%	28.4%	24.5%	26.0%
	Adjusted Residual	4.4	-.2	-.4	-2.8	.6	-1.2	
Opinion Seeker	Count	7	15	12	14	1	56	105
	Expected Count	18.0	11.2	16.3	17.0	5.3	37.3	105.0
	% within Subject	1.8%	6.1%	3.3%	3.7%	0.9%	6.8%	4.5%
	Adjusted Residual	-2.9	1.2	-1.2	-.8	-2.0	3.9	
Social Role	Count	5	3	2	1	2	6	19
	Expected Count	3.2	2.0	3.0	3.1	1.0	6.8	19.0
	% within Subject	1.3%	1.2%	0.6%	0.3%	1.7%	0.7%	0.8%
	Adjusted Residual	1.1	.7	-.6	-1.3	1.1	-.4	
Supporter	Count	26	14	16	30	5	50	141
	Expected Count	24.1	15.0	21.9	22.8	7.1	50.1	141.0
	% within Subject	6.6%	5.7%	4.4%	8.0%	4.3%	6.1%	6.1%
	Adjusted Residual	.4	-.3	-1.4	1.7	-.8	.0	
Total	Count	396	247	360	374	116	823	2316
	Expected Count	396.0	247.0	360.0	374.0	116.0	823.0	2316.0
	% within Subject	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 12. *Participatory role distribution among subjects in team 3.*

		KAR	KAS	KES	KJH	Total
Challenger	Count	34	19	9	4	66
	Expected Count	29.5	18.7	11.3	6.5	66.0
	% within Subject	10.5%	9.2%	7.2%	5.6%	9.1%
	Adjusted Residual	1.2	.1	-.8	-1.1	
Content Provider	Count	136	86	45	20	287
	Expected Count	128.1	81.2	49.3	28.4	287.0
	% within Subject	41.8%	41.7%	36.0%	27.8%	39.4%
	Adjusted Residual	1.2	.8	-.9	-2.1	
Content Seeker	Count	25	18	25	8	76
	Expected Count	33.9	21.5	13.0	7.5	76.0
	% within Subject	7.7%	8.7%	20.0%	11.1%	10.4%
	Adjusted Residual	-2.2	-.9	3.8	.2	
Follower	Count	14	17	10	12	53
	Expected Count	23.7	15.0	9.1	5.2	53.0
	% within Subject	4.3%	8.3%	8.0%	16.7%	7.3%
	Adjusted Residual	-2.8	.6	.3	3.2	
Opinion Giver	Count	70	49	22	20	161
	Expected Count	71.9	45.6	27.6	15.9	161.0
	% within Subject	21.5%	23.8%	17.6%	27.8%	22.1%
	Adjusted Residual	-.3	.7	-1.3	1.2	
Opinion Seeker	Count	21	5	3	4	33
	Expected Count	14.7	9.3	5.7	3.3	33.0
	% within Subject	6.5%	2.4%	2.4%	5.6%	4.5%
	Adjusted Residual	2.2	-1.7	-1.3	.4	
Social Role	Count	11	1	2	0	14
	Expected Count	6.3	4.0	2.4	1.4	14.0
	% within Subject	3.4%	0.5%	1.6%	0.0%	1.9%
	Adjusted Residual	2.6	-1.8	-.3	-1.3	
Supporter	Count	14	11	9	4	38
	Expected Count	17.0	10.8	6.5	3.8	38.0
	% within Subject	4.3%	5.3%	7.2%	5.6%	5.2%
	Adjusted Residual	-1.0	.1	1.1	.1	
Total	Count	325	206	125	72	728
	Expected Count	325.0	206.0	125.0	72.0	728.0
	% within Subject	100.0%	100.0%	100.0%	100.0%	100.0%

Table 13. *Participatory role distribution among subjects in team 4.*

		OJM	OLB (SM)	OLH	ORL	Total
Challenger	Count	7	6	8	5	26
	Expected Count	5.0	5.4	5.3	10.3	26.0
	% within Subject	6.3%	5.0%	6.8%	2.2%	4.5%
	Adjusted Residual	1.0	.3	1.4	-2.2	
Content Provider	Count	37	40	30	79	186
	Expected Count	36.0	38.9	37.6	73.6	186.0
	% within Subject	33.0%	33.1%	25.6%	34.5%	32.1%
	Adjusted Residual	.2	.2	-1.7	1.0	
Content Seeker	Count	8	28	10	24	70
	Expected Count	13.5	14.6	14.1	27.7	70.0
	% within Subject	7.1%	23.1%	8.5%	10.5%	12.1%
	Adjusted Residual	-1.8	4.2	-1.3	-1.0	
Follower	Count	15	8	15	35	73
	Expected Count	14.1	15.3	14.8	28.9	73.0
	% within Subject	13.4%	6.6%	12.8%	15.3%	12.6%
	Adjusted Residual	.3	-2.2	.1	1.6	
Opinion Giver	Count	37	26	36	55	154
	Expected Count	29.8	32.2	31.1	60.9	154.0
	% within Subject	33.0%	21.5%	30.8%	24.0%	26.6%
	Adjusted Residual	1.7	-1.4	1.1	-1.1	
Opinion Seeker	Count	2	11	5	16	34
	Expected Count	6.6	7.1	6.9	13.4	34.0
	% within Subject	1.8%	9.1%	4.3%	7.0%	5.9%
	Adjusted Residual	-2.0	1.7	-.8	.9	
Social Role	Count	2	1	1	5	9
	Expected Count	1.7	1.9	1.8	3.6	9.0
	% within Subject	1.8%	0.8%	0.9%	2.2%	1.6%
	Adjusted Residual	.2	-.7	-.7	1.0	
Supporter	Count	4	1	12	10	27
	Expected Count	5.2	5.6	5.5	10.7	27.0
	% within Subject	3.6%	0.8%	10.3%	4.4%	4.7%
	Adjusted Residual	-.6	-2.3	3.2	-.3	
Total	Count	112	121	117	229	579
	Expected Count	112.0	121.0	117.0	229.0	579.0
	% within Subject	100.0%	100.0%	100.0%	100.0%	100.0%

Table 14. *Participatory role distribution among subjects in team 5.*

		BBV (SM)	BJG	BLR	BMS	BRK	Total
Challenger	Count	8	13	24	17	16	78
	Expected Count	9.3	13.0	23.5	12.3	19.9	78.0
	% within Subject	5.6%	6.6%	6.7%	9.1%	5.3%	6.6%
	Adjusted Residual	-.5	.0	.1	1.5	-1.0	
Content Provider	Count	27	100	122	61	110	420
	Expected Count	50.3	69.8	126.5	66.3	107.0	420.0
	% within Subject	19.0%	50.8%	34.2%	32.6%	36.4%	35.4%
	Adjusted Residual	-4.4	4.9	-.6	-.9	.4	
Content Seeker	Count	27	21	48	28	20	144
	Expected Count	17.3	23.9	43.4	22.7	36.7	144.0
	% within Subject	19.0%	10.7%	13.4%	15.0%	6.6%	12.2%
	Adjusted Residual	2.7	-.7	.9	1.3	-3.4	
Follower	Count	29	13	27	16	37	122
	Expected Count	14.6	20.3	36.8	19.3	31.1	122.0
	% within Subject	20.4%	6.6%	7.6%	8.6%	12.3%	10.3%
	Adjusted Residual	4.2	-1.9	-2.0	-.9	1.3	
Opinion Giver	Count	37	40	96	41	101	315
	Expected Count	37.7	52.4	94.9	49.7	80.3	315.0
	% within Subject	26.1%	20.3%	26.9%	21.9%	33.4%	26.6%
	Adjusted Residual	-.2	-2.2	.2	-1.6	3.1	
Opinion Seeker	Count	4	4	17	15	11	51
	Expected Count	6.1	8.5	15.4	8.0	13.0	51.0
	% within Subject	2.8%	2.0%	4.8%	8.0%	3.6%	4.3%
	Adjusted Residual	-.9	-1.7	.5	2.7	-.7	
Social Role	Count	2	0	2	1	2	7
	Expected Count	.8	1.2	2.1	1.1	1.8	7.0
	% within Subject	1.4%	0.0%	0.6%	0.5%	0.7%	0.6%
	Adjusted Residual	1.4	-1.2	-.1	-.1	.2	
Supporter	Count	8	6	21	8	5	48
	Expected Count	5.8	8.0	14.5	7.6	12.2	48.0
	% within Subject	5.6%	3.0%	5.9%	4.3%	1.7%	4.1%
	Adjusted Residual	1.0	-.8	2.1	.2	-2.4	
Total	Count	142	197	357	187	302	1185
	Expected Count	142.0	197.0	357.0	187.0	302.0	1185.0
	% within Subject	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%