On the Adaptations of the Scrum Framework Software Development Events: Literature and Practitioners Analysis using Feature Models

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Abstract: Scrum is one of the most well-known and used agile methods for software development. Practitioners highlight the Sprint event as the heart of Scrum. Different kinds of Scrum events aid at performing Sprints. We gathered evidence of industrial adaptations of Scrum events based on the existing reporting literature and a survey with practitioners. We grouped, represented and unified these adaptations in terms of feature models. Such representation aids to register practitioners' knowledge, thus creating an structure capable of instantiating it to new software development solutions deployment.

1 INTRODUCTION

Agile methods have become increasingly popular in software development. Scrum is one of the most adopted in industry Sharma and Hasteer (2016). In a survey conducted by Alliance (2017), 94% of respondents use SCRUM.

The Scrum structure is formed by the following main components: roles, events, artifacts, and rules. In this paper we will focus on the events that take place in the operation of Scrum. According to Schwaber and Sutherland (2017), the Scrum events create regularity and minimizing the need for meetings. Among these events, the Sprint is considered the most important one, being called the "heart of Scrum", playing the role of a container for the other events necessary for the conduction of the Scrum Schwaber and Sutherland (2017).

We have observed there are few studies specifically dedicated to reporting the adaptations of the Scrum events, as we understand different software development projects have particularities. Such events are essential to establish the quality and assertiveness of the development time of the software increments generated in the process of conducting Scrum. For this, we performed a Systematic Mapping Study (SMS) of the literature on industry reported adaptations of the Scrum events. As a complementary strategy, we also carried out a survey with Scrum practitioners to confirm the SMS results.

The adaptations involved in the components of Scrum, including events, are possible as the Scrum is a flexible framework Schwaber and Sutherland (2017). In provides several different features, for example an event might have different time frames for similar projects. According to Krzysztof and Eisenecker (2000), a feature is a property of the system that is relevant to some stakeholders and is used to capture common points or discriminate between systems in a framework (family). Assuming that Scrum can be understand as a family with possible distinguish project feature instances (systems), we can use feature models to represent such abstraction. Therefore, similar and variable Scrum events aspects can be represented in such models Krzysztof and Eisenecker (2000).

Being aware of which features can be selected and respective choices makes Scrum deployment more manageable. To do so, we gathered, analyzed and elaborated feature models for Scrum events from the SMS and the survey. Once we produced feature models for the SMS and the survey, we conducted a process of unification of such models making them compliant with the Scrum guide Schwaber and Sutherland (2017). In addition, we presented an example of instantiation of such feature models.

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2 BACKGROUND AND RELATED WORK

2.1 The Scrum Framework Events

To be able to identify how adaptations in Scrum events take place we followed the Scrum guides 2017 Schwaber and Sutherland (2017) and 2010 Schwaber and Sutherland (2010).

The main Scrum event is the Sprint. Sprints are interactions in which the product (software) is developed. At the end of each Sprint a functional version of the product must be released. The other Scrum events are defined according to the Sprint and are detailed as follows.

Release Planning. This event is no longer compulsory since 2011. In general, the objective of this artifact is to plan how the increments produced in each Sprint will be integrated and delivered in functional and valuable versions for investors. Scrum does not mention a specific time-boxed for this event.

Sprint Planning. It is a meeting, in which people plan the work to be done in a Sprint. This event tries to answering the following questions: **What** is the purpose of the Sprint?; **What** should be delivered as a result of increasing a Sprint?; and **How** will the work be done to deliver the increment?

Daily Scrum. It is a meeting that takes place every day for the duration of the Sprint. Three questions must be answered by all members of the Dev. Team: **What was done yesterday to achieve the Sprint goal?**; **What will be done today to achieve the Sprint goal?**; and **Have obstacles been found that can interfere with the progress of the Sprint?**

Sprint Review. The focus of this meeting is on what was produced in a Sprint.

Sprint Retrospective. This event occurs after the Sprint Review and before the next Sprint Planning. It is an opportunity for the Scrum roles to reflect on relationships, processes and tools used and to create an improvement plan to be applied in the next Sprint.

2.2 Feature Modeling

According to Czarnecki et al. (2005) feature is a system property relevant to some stakeholders (customers, analysts, architects, developers, system administrators, etc.) and is used to capture similarities or differences between systems in a family. Figure 1[1] shows an example of a feature model.

A feature model is composed of basic elements, namely (Mendonça, 2009): feature diagram, composition rules, and relational analysis. In Figure 1, features are represented by the tree nodes described in the feature diagram, and in this hierarchy the child features can be classified as Takeyama and Chiba (2013): **Mandatory** - feature must be selected; **Optional** - feature may be selected; **Or** - at least one feature must be selected; **Alternative** - only one feature should be selected; and **Abstract** - does not impact in the implementation of a system.

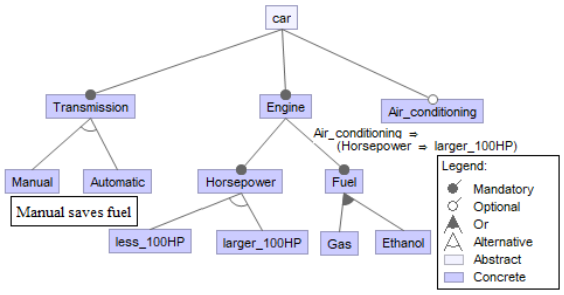

Figure 1: Example of a Feature Model (Kang et al., 1990).

Composition Rules define the relationship between features that cannot be expressed in feature diagrams (Lobo and Rubira, 2009). In Figure 1, there is a composition rule which requires the *car* to have an *Engine* with *Horsepower* greater than 100 to support the air conditioning.

2.3 Related Work

In the work of Ashraf and Aftab (2017), a Systematic Literature Review (SLR) was carried out. While in this paper we are concerned with highlighting the adaptations practiced in Scrum events, the work of Ashraf and Aftab (2017) was concerned with the Scrum process and its variations due to the area in which it was used. Despite the Ashraf and Aftab (2017) work providing one research questions for events, it only sought to reflect on new practices for the events, with no worrying about compliance with the recommendations of the Scrum guide. Another difference is we confirm the SMS findings with a survey with practitioners, whereas the study of Ashraf and Aftab (2017) relies only in the secondary study findings.

With respect to the work of Diebold et al. (2015), there are similarities in relation to the direct search for the practitioners' experience. For this paper we used the survey investigation method, while Diebold et al. (2015) used structured interviews. As in our study, Diebold et al. (2015) also gave importance to compliance with the recommendations of the Scrum guide, regarding the adaptations of its components. Although Diebold et al. (2015)'s work is not exclusively about Scrum events, it brings relevant informa-

[1]Modeled with FeatureIDE - http://www.featureide.com

tion about them. Another aspect of similarity was the comparison of the practitioners' experiences with that found in the literature. The main difference is in the type of study and in the selection of participants. We sought an international approach in the survey, while in the interviews conducted in Diebold et al. (2015) portrayed the practices in the German industry.

3 ADAPTATIONS FOR SCRUM EVENTS

The adaptations reported for Scrum events in this work are a cut to systematic mapping of the literature and a survey conducted with Scrum practitioners. In the next sections we present the two studies that were carried out. The presentation will be made in a summarized form, for a space limit issue focusing on the adaptations in the Scrum events.

3.1 Adaptations from the Literature

We performed an SMS[2] to find reported adaptations of the Scrum events following recommendations of Petersen et al. (2015) and Kitchenham et al. (2015).

We searched studies in five electronic databases. We also manually searched studies in 11 journals and 17 conferences of Software Engineering. We came up with 281 primary studies. By applying inclusion/exclusion criteria we reduced such list to 50. We used the StArt[3] tool to aid us at organizing retrieved studies. The list of resultant studies is available at https://zenodo.org/record/3357804.

3.1.1 Findings for Literature Scrum Events

We wanted to answer the following research question with the SMS: **RQ**: Which Scrum events have been adapted? This question was supported by the following extraction information: Do events follow the Scrum guide recommendations? and What is the time-frame for each event?

Table 1 shows the studies with adaptations to Scrum events. Out from 50 selected studies, 31 presented adaptations in the events.

Rows in table showing more than one study were grouped by the study that affected the greatest number of events among them (Total). We can identify the event with most adaptations is Sprint (28/31), and the one with less adaptations is Release Planning (1/31).

Table 2 lists extracted information related to compliance with the Scrum guide recommendations.

We can observe in Table 2 none of the studies fully comply with the Scrum recommendations ("Yes" column). 20 out of 31 studies partially comply with the recommendations ("Partial" column) and 11 out of 31 do not comply with Scrum recommendations. Partial means one study mentions more than one event and at least one of them complied with the Scrum recommendations.

Sprint.
With regard to Sprint, we found most studies pointed a time-box between one and four weeks. Of the 20 selected studies, one did not inform the time-box adopted. Another study reported an 8-week time-boxed Sprint. In addition, one study reported a 2.5-week time-boxed for Sprint. Half of the studies (10/20) reported Sprint with a 2-week time-boxed.

Daily Scrum.
As for Daily Scrum in addition to time-boxed, we analyzed the frequency in which the meeting was held and the form of presence in it.

Regarding *time-boxed*, he observed the following time intervals: 5 minutes, 15 minutes, between 15 to 20 minutes and between 15 to 35 minutes. Regarding the *frequency* in which the Daily Scrum was performed, the studies mentioned the following: daily, twice a week, 3 times a week and many times a day. For the type of *presence* of participants in the meeting, the following was found: physical presence, and virtual presence. Being that in the virtual presence the following means were pointed out: Google groups, Google Docs, email, chats.

Sprint Review.
Regarding the time-boxed of the Sprint Review event, only two studies (2/20) mentioned the time boxed used and were: 5 minutes and 8 hours.

Sprint Retrospective.
As for the Sprint Retrospective, only three studies reported the time allotted for this event, which were as follows: 5 minutes, 15 minutes, 30 minutes and 1 hour.

Sprint Planning.
Only four studies reported times for the Sprint Planning event. In the studies, time-boxed of 2, 3, 16 hours and 1 week were mentioned.

Release Planning.
Regarding Release Planning, only one study reported such an event and adopted a 1-week time-boxed.

3.1.2 Feature Modeling of Literature Events Adaptations

With the information found in the SMS for the adaptation of Scrum events, a feature model was elaborated for them.

[2]Currentlyunderreviewinajournal.
[3]http://lapes.dc.ufscar.br/tools/start_tool

Table 1: Scrum events with adaptations.

Study ID	Sprint	Daily Scrum	Review	Retrospective	Planning	Release
S3, S8, S9, S28, S52, S58	✓					
S4	✓	✓		✓	✓	
S5, S6, S26, S31, S38	✓	✓	✓	✓	✓	✓
S11	✓		✓		✓	
S12, S13, S17, S22, S29, S36, S37, S41, S43, S49	✓	✓				
S14	✓	✓	✓	✓	✓	
S15	✓	✓	✓	✓		
S20			✓			
S30	✓			✓		
S33				✓		
S44		✓				
S48	✓	✓	✓		✓	
S53	✓			✓	✓	
Total	**28**	**17**	**07**	**08**	**07**	**01**

Table 2: Compliance of event adaptations with Scrum guide.

Study ID	Count	Yes	Partial	No
None	00	✓		
S4, S5, S6, S8, S9, S11, S12, S13, S14, S15, S22, S28, S29, S30, S37, S41, S48, S49, S53, S58	20		✓	
S3, S17, S20, S26, S31, S33, S36, S38, S43, S44, S52	11			✓
Total	**31**	**00**	**20**	**11**

Due to the limited space and to favor the reading of the feature models, we will use a notation for features and a short description for the event names.

Notation for Features.
The identifier for each feature will be composed as follows: **F99xxM**, where the letter **F** to represent the word Feature, **99** represents a sequential for feature, **xx** is an abbreviation for the event name, and the letter **M** identifies it as an SMS source feature.

Short Names for Events.
In the notation for identifying the features, the letters **xx** will be replaced with the letters corresponding to each event as follows: rp - Release Planning; st - Sprint; ds - Daily Scrum; sw - Sprint Review; sr - Sprint Retrospective; and sp - Sprint Planning.

The short names presented for the events will be used to identify the events in the feature model at the top level, only they will be written in capital letters.

Table 3 shows the adaptations found in the SLM and described as features. Table 3 serves as support for the elaboration of the feature model for events based on SMS.

Figure 2 shows the feature model that originated from the data in Table 3.

Table 3: Features of each Scrum event in SMS.

ID Feature	Description	ID Feature	Description
F01rpM	1 week	F15dsM	many times a day
F02stM	1 week	F16dsM	physical
F03stM	2 weeks	F17dsM	Virtual (email, chat)
F04stM	2.5 weeks	F18dsM	Virtual (Google Groups, Google Docs)
F05stM	3 weeks	F19swM	5 minutes
F06stM	4 weeks	F20swM	8 hours
F07stM	8 weeks	F21srM	5 minutes
F08dsM	5 minutes	F22srM	15 minutes
F09dsM	15 minutes	F23srM	30 minutes
F10dsM	15 to 20 minutes	F24srM	1 hour
F11dsM	15 to 35 minutes	F25spM	2 hours
F12dsM	daily	F26spM	3 hours
F13dsM	twice a week	F27spM	16 hours
F14dsM	3 times a week	F28spM	1 week

3.2 Adaptations from the Practitioners Survey

To capture the experience of practitioners regarding the use of Scrum, a survey was conducted. This survey was carried out according to Forza (2002), observing the following steps: Planning, Pilot Test, Data Collection and Analysis of Results.

The research was carried out with specialists from Brazil and abroad who work in software development and make use of the Scrum framework in this environment. The total respondents of the survey were 14 practitioners. It was observed that these 14 practitioners answered all questions adequately with the respective statements, with no inconsistent data.

Regarding the experience of respondents in using Scrum 85.7% answered that they have used Scrum for more than a year. Of this total, 35.7% use between 1 and 3 years, 21.4% use Scrum between 4 and 6 years and 28.6% use Scrum for more than six years.

Below, we detail the main findings about practitioners' responses.

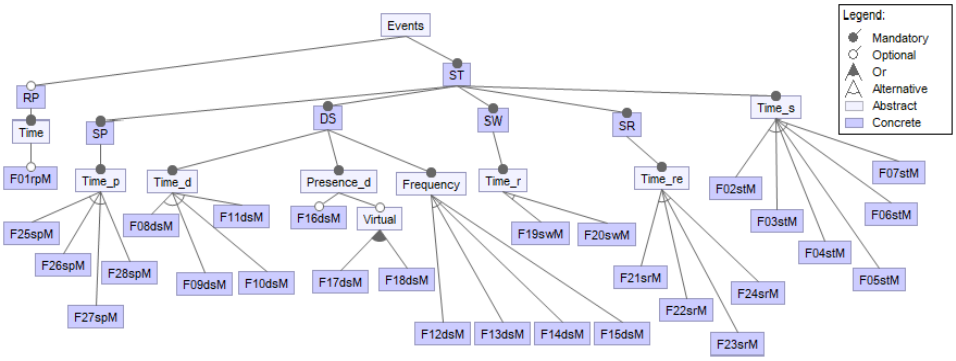

Figure 2: Feature model of SMS Scrum Events Adaptations.

3.2.1 Findings for Survey Scrum Events

The information obtained from the Survey for the events was gathered and classified. It does not matter at that moment whether or not they are in compliance with the recommendations of the Scrum guide.

For the sake of space limitations, we will not detail the percentages of responses. Since for us it is enough that an adaptation has been cited by a respondent for it to be considered in the elaboration of the models.

In the sequence, information acquired for each event will be described individually.

Release Planning.

This event became optional after the 2010 version of Scrum Schwaber and Sutherland (2010), but was found in the Survey responses,when asked: *How long did this event last?* In the responses, the time of 1 day was unanimously pointed out.

Sprint Planning.

For this event, two questions were asked, namely: How long did Sprint Planning last? and When is the best time to carry out Sprint Planning?

Regarding the duration of the event, the following were identified: following alternatives: 2 hours or less, 3 hours, between 4 and 5 hours. For the moment when Sprint Planning was carried out, the answers were concentrated on: at the beginning of Sprint and before starting Sprint.

Sprint.

For Sprint the following questions were asked: How long does the Sprint last? What is the best day of the week to start Sprint? When is the best time to hold the Planning, Review and Retrospective? When is the best time to perform software tests? What technique was used to estimate Sprint time?

For the duration of Sprint were reported: 1 week, 2 weeks and 4 weeks. Regarding the best day of the week to start Sprint, the following were pointed out: Monday, Tuesday, Wednesday and Thursday. For the time to hold the Planning events, Review and Retrospective, got the following answers: on separate days, on the same day, Review and Retrospective on the same day and planning on another day. Regarding the timing of the tests: in the sprint itself, in the next sprint. Regarding the technique used to estimate the sprint time, the following responses were mentioned: Planning Poker, Task estimation and Planning Poker translated into hours.

Daily Scrum.

The Daily Meeting presented the duration of 15 minutes, informed by the respondents and there was no mention of other times. As for the frequency in which the daily meeting took place, it was mentioned by most respondents that it was held daily. As for presence, mention was made in addition to physical presence, virtual presence, which had the following forms mentioned: Skype for Business, Microsoft Teams, Skype, Zoom meeting.

Sprint Review.

For this event two questions were asked: How long does the Sprint Review last? When was the Sprint Review performed?

For the duration of this event, the following responses were obtained: less than 1 hour, 1 hour, 2 hours and 3 hours. Regarding the moment when the Sprint Review was carried out, the answers were mentioned: carried out on the last day of the Sprint, carried out after the end of the Sprint and carried out before the last day of the Sprint.

Sprint Retrospective.

For the Sprint Retrospective the following questions were asked: How long does the Sprint Retrospective last? How were the improvements identified in the Sprint Retrospective handled? What technique was used to conduct the Sprint Retrospective meeting?

Regarding the duration of this event, the respondents indicated: 45 minutes or less, 1 hour, 2 hours. For the improvements identified in this event, the respondents informed that they were treated as follows: they were inserted as items of the PB to be imple-

mented in the next Sprints and were implemented in the next Sprint. Regarding the way the meeting of this event was conducted, the respondents reported the following: (i) any dynamics that added value, (ii) 3 questions, what was good, what can improve, action items, (iv) Useful / Viable - points to improve or maintain, (v) Balloon Technique: Stop, Continue and Start, (vi) 4L, Sail boat, speedcar, (vii) W3 or Sad / Mad / Glad.

3.2.2 Feature Modeling of Survey Events Adaptations

With the information found with a survey for the adaptations of Scrum events, a model feature was elaborated for them. It used the same notation defined in Section 3.1.2, with a small change in the feature identifier. Instead of the feature ID ending with the letter M, it will end with the letter S to indicate that the origin of the feature is from the survey.

Table 4 shows the features and their descriptions.

Based on the information in Table 4, the feature model was elaborated, which is shown in Figure 3.

4 FEATURE UNIFICATION PROCESS

The feature models generated for SMS and Survey represent the realities found in these studies. Thus, the representation of the feature include features that are not in accordance with the recommendations of the SCRUM guide. Also, as they were conducted independently, to confirm the information, some features may be in both models and for consolidation between them, they need to be unified.

Based on Tables 3 and 4 we prepared a unified model for Scrum events with adaptations found in the SMS and the Survey (see Figures 4 and 5).

4.1 Scrum Guide Compliance Check

The inconsistencies in the adaptations of Scrum events were addressed individually for each event. We have identified features that do not conform to the Scrum Guide for the SMS and the Survey.

Release Planning - RP.

The feature found for this event, both SMS and the Survey, was that of time. As mentioned earlier, this event is no longer formally part of the Scrum guide since 2010. However, there were time notes for this event and for 1 week and 1 day respectively for the SMS and the Survey. As the Scrum guide does not mention time, the features *F01rpM* and *F01rpS* will be part of the unified model for the events.

Sprint - ST.

Regarding the time, only one feature was eliminated due to inconsistency, which is *F07stM* of the SMS, as Scrum stipulates as a time of deduction for String no more than 30 days.

The other features do not represent inconsistencies with the Scrum guide or are not mentioned as problems.

Daily Scrum - DS.

Regarding the Daily Scrum time, the following features of the SMS were chosen: *F10dsM* and *F11dsM*. They were eliminated because they exceeded the time allocated for this event by Scrum, which is a maximum of 15 minutes. For the Survey, as for time, there was no inconsistent feature and relation to the Scrum guide.

Regarding the Daily Scrum's frequency, the following featues of SMS are at odds with the Scrum guide: *F13dsM*, *F14dsM*, *F15dsM*. Because Scrum mentions that this event must be daily and one on the day, in the same place and time.

Sprint Review - SW.

As for the duration of this event, only the *F20swM* feature will be eliminated. Because Scrum mentions that for a 30-day Sprint the duration of this event must be 4 hours.

Regarding when to start this event the *F29swS* and *F30swS* will be eliminated, as the Scrum guide defines that it must be carried out at the end of the Sprint.

Sprint Retrospective - SR.

No features were found that do not comply with the recommendations in the Scrum guide.

Sprint Planning - SP.

Regarding the duration of this event, two features were eliminated: *F27spM* and *F28spM*, as they are outside the time-boxed defined by the Scrum guide for this event, which is a maximum of 8 hours for a 30-day Sprint.

With when this event should start, the Scrum guide does not make it clear, so we assume that the two features found for the Survey are correct.

4.2 Elimination of Redundant Features

After defining the feature models according to the recommendations of the Scrum guide, the features that were present in both Survey and SMS models were eliminated. In these cases, we gave preference to the Survey feature to compose the unified model.

To eliminate the redundancies of the features in the SMS and Survey models, we analyze each event individually.

Table 4: Features of Scrum event in Survey.

ID Feature	Description	ID Feature	Description	ID Feature	Description
F01rpS	1 day	F17dsS	15 minutes	F32srS	1 hour
F02stS	1 week	F18dsS	daily	F33srS	2 hours
F03stS	2 weeks	F19dsS	Presence: physics	F34srS	Improvement: insert items in the PB to do in the next sprint
F04stS	4 weeks	F20dsS	Presence: virtual: Skype for Business	F35srS	Improvement: do in the next sprint
F05stS	Start : Monday	F21dsS	Presence: virtual: Microsoft Teams	F36srS	Manage: any dynamics that added value
F06stS	Start : Tuesday	F22dsS	Presence: virtual: Skype	F37srS	Manage: 3 questions, What was good? What can improve? action items
F07stS	Start: Wednesday	F23dsS	Presence: virtual: Zoom meeting	F38srS	Manage: Useful / Viable - points to improve or maintain
F08stS	Start: Thursday	F24swS	less than 1 hour	F39srS	Manage: Balloon Technique: Stop, Continue and Start
F09stS	Do_sp_sw_sr: on separate days	F25swS	1 hour	F40srS	Manage: 4L, Sail boat, speedcar
F10stS	Do_sp_sw_sr: on the same day	F26swS	2 hours	F41srS	Manage: W3 or Sad / Mad / Glad
F11stS	Do_sp_sw_sr: Review and Retrospective on the same day and planning on another day	F27swS	3 hours	F42spS	2 hours or less
F12stS	Tests: in the sprint itself	F28swS	Start: on the last day of the Sprint	F43spS	3 hours
F13stS	Tests: in the next sprint	F29swS	Start: after the end of the Sprint	F44spS	3 at 5 hours
F14stS	Tec_Estimate: Planning Poker	F30swS	Start: before the last day of the Sprint	F45spS	Start: sprint start
F15stS	Tec_Estimate: Task estimation	F31srS	45 minutes or less	F46spS	Start: before starting the sprint
F16stS	Tec_Estimate: Planning Poker translated into hours				

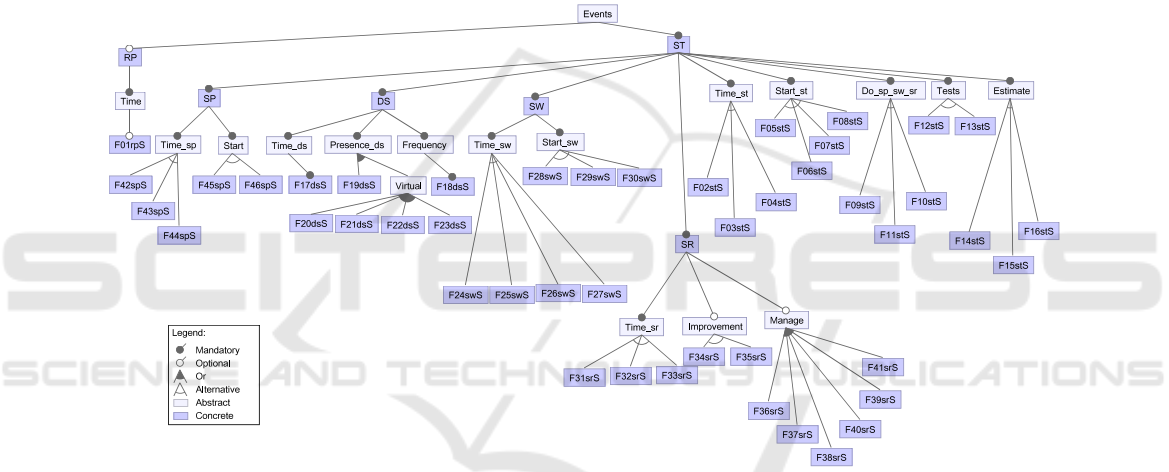

Figure 3: Feature model of Survey Scrum Events Adaptations.

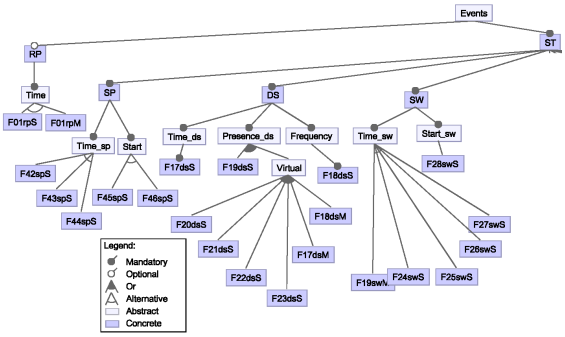

Figure 4: Feature model of Unified Scrum Event Adaptations - Part 1.

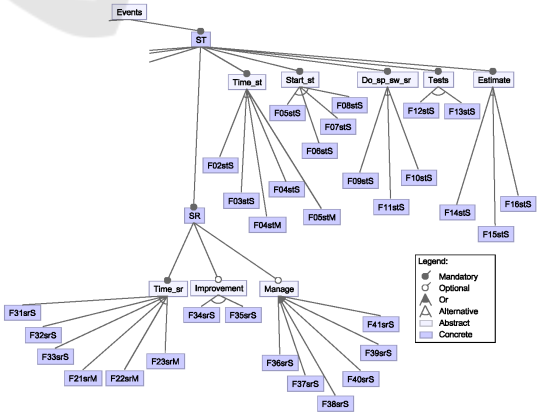

Figure 5: Feature model of Unified Scrum Event Adaptations - Part 2.

Release Planning - RP. No feature redundancies were found for this event. Therefore, the features found were part of the unified model for the event.

Sprint - ST. For Sprint, with regard to the duration feature, the same features were found in the SMS as in the Survey. We then eliminated the features of SMS in the composition of the unified model of events, which

are: *F02stM*, *F03stM*, *F06stM*. We included the features: *F04stM* and *F05stM*, in the unified model for the events, as they are different from all the features found for the Survey. The other features for this event are already represented by the features found in the Survey and which have already gone through the verification process for compliance with the Scrum guide.
Daily Scrum - DS. Regarding time, the *F09dsM* and *F17dsS* features are the same and we opted for the Survey feature to compose the unified model for the event. As for the frequency of this event, the *F12dsM* feature is the same as the *F18dsS* feature, we chose to integrate the Survey feature into the model. As for the form of presence for this event the features *F16dsM* and *F19dsS* are the same, we chose to compose the unified model of events the feature *F19dsS*.The SMS *F17dsM* and *F18dsM* features will be incorporated into the unified model for the events, as they do not have correspondents in the Survey.
Sprint Review - SW. As for the duration of these events, we have incorporated the *F19swM* feature together with the others in the Survey to the unified model for the event, as they are not the same and met the recommendations of the Scrum guide.
Sprint Retrospective - SR. As for the duration of these events, only the *F24srM* and *F32srS* features are the same, we chose to keep the Survey's source feature. The others with respect to time will be incorporated into the model because they have no correspondents between them.
Sprint Planning - SP. Regarding the duration of this event, the features of the SMS and the Survey are the same: *F26spM* and *F43spS*, we chose to keep only that of the Survey in the unified model. The *F42spS* feature includes the *F25spM* feature, so we will incorporate the *F42spS* feature in the unified model.

5 CONCLUSIONS

We observed there is little information available on handling Scrum events. The literature most often reports the features of the duration of events, but Scrum has many other details of equal importance for the events. In the Survey conducted, we asked questions to understand the aspects not found in the literature and are part of the Scrum guide. Even in the Survey, few responses were not in accordance with the Scrum recommendations. We understand this is due to the fact participants had a good experience in Scrum practices. We then developed a unified model of adaptations. The feature model is especially useful for grouping and classifying the information obtained, giving visibility to the knowledge reported in the literature and with practitioners. The feature model allows to instantiate new versions of Scrum, within the guidelines' recommendations, for application in software development projects.

As future work we will validate the resulting model based on an empirical study. Another opportunity for future is the statement of guidelines to create a version of Scrum more suitable for the software development companies, based on feature models.

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