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Assessing the Performance of Agile Teams

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Abstract. Selecting a well performing agile software development team to develop a particular software is a complex issue for public authorities. This selection is often based on the estimated total cost of the project in an official request for proposals. In this paper we describe an alternative approach where three performance factors and the estimated cost were assessed and weighted to find the best agile team for a particular project. Five agile software development teams that fulfilled predefined technical requirements were invited to take part in one day workshops. The public authority involved wanted to assess both how each team performed during the workshops and the quality of the deliverables they handed in. The three performance factors were: 1) team collaboration and user experience focus, 2) user stories delivery and 3) the quality of the code. We describe the process of assessing the three performance factors during and after the workshops and the results of the assessments. The team that focused on one user story during the workshop and emphasized the three different quality factors, user experience, accessibility and security, got the highest rating from the assessment and were selected for the project. We also describe the lessons learned after concluding the assessment.

Keywords: User experience, Accessibility, Security, Agile development, Team collaboration, Agile teams.

1 Introduction

When public authorities want to make new software systems to be used by citizens and employees for solving various tasks they often negotiate with software companies for developing the software. The selection of the software company for making the software needs to be free and open for competition according to European Union legislation, so the public authorities must issue a public request for proposal (RFP). Typically the RFP contains two sections: (1) the requirements and needs for the system to be developed, and (2) the selection criteria [12]. Often the selection criteria is based on the cost solely, so the software companies estimate the hours needed to be able to develop the software fulfilling the requirements and needs stated. The company with the lowest prize gets the job [12]. In a case study of four software companies in Denmark developing for public authorities, the software companies focused on what the public authorities are willing to pay for and what they wanted to citizens to be able to do [2]. So the software companies did not include quality factors like user experience (UX) or security issues, in their proposal, if it was not requested in the RFP.

In some cases the selection criteria is based on both the prize and quality factors, so the price could weight 60% and the quality criteria 40% for example [12]. Requirements for quality factors, like user experience (UX) and security, can be included in the requirement section of the RTF defining the level of the UX and security in the developed system. The requirements can also be included in the selection criteria, defining how much weight in the selection process the UX and security factors have [22]. Typically, the usage of particular methods like user testing and the frequency of using those methods would be stated in the selection criteria. Another option would be that the public authority may state performance criteria for the users, for example that the users will be able to accomplish a particular task within a particular time limit [22]. One possibility is to base the selection criteria on the competences of the software team getting the job, but that is not frequently done. The selection criteria should state the wanted knowledge, skills and competences of the team, in that case. Possibly, the criteria could also include the focus on quality aspects that the team should have. In any case, the objective of the process is to find the best team for the job according the predefined criteria and thereby get the best outcome for the money spent.

There are many aspects that affect a project outcome. A study of four similar software teams developing software to fit the same needs, described 1 to 6 variation in the prizes of the outcome [21]. The teams were similar in technical competences. The quality of the outcome was also assessed and the team with the next lowest price scored best on the three quality aspects in the study, usability, maintainability and reliability. That team had one project manager, one developer and one interaction designer in the team, but the other teams had two developers and one project manager. The best team used intermediate process models for the development, with analysis and design in the first four weeks, then implementation from week 4 to 10 and testing in the last six weeks of the project [21].

In this paper we describe an approach, where the performance of five agile software development teams was evaluated as a part of the selection criteria for selecting the best agile team for making a web service. The performance factors included: 1) team collaboration and user experience focus, 2) user stories delivered and 3) quality of code including accessibility and security. The performance factors were assessed during and after a one day workshop with the team, where the teams were observed and their deliverables reviewed. The performance factors weighted 70% and the cost 30% in the selection criteria for the best agile team.

2 Related Work on the Performance Factors

In this section we briefly describe the related literature on the performance factors evaluated in this study. First we give a brief overview of agile development and team collaboration, we explain the format and usage of user stories and then we briefly describe the concept of user experience and code quality.

2.1 Agile Development and Team Collaboration

The agile process Scrum [20] has gained popularity in the software industry in recent years. According to an international survey, Scrum was the most popular process of the

agile processes with more than 50% of the IT professionals surveyed were using it [23]. A similar trend is seen in the software industry in Iceland, but the lean process Kanban [17] has also been gaining popularity lately [15].

A characteristic of Scrum is the observation that small, cross-functional teams historically produce the best results. Scrum is based on a rugby metaphor in which the team's contribution is more important than each individual contribution. Scrum teams typically consists of people with three major roles: 1) a Scrum Master that acts as project manager/buffer to the outside world; 2) a Product Owner that represents stakeholders, and 3) a team of developers (less than 10). One of the twelve principles behind the agile manifesto is: "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation." [16]. In agile development the teams should collaborate openly and all the team is responsible for delivering a potentially shippable product after each sprint.

Some of the more important artifacts and ceremonies within Scrum is the Sprint, which defines 15-30 days iteration, the Product backlog of requirements described by user stories and managed by the Product Owner and the Daily Scrum meeting, which is the daily meeting for the team and the Scrum Master to plan the work of the day and report what was done the day before [20].

2.2 User Stories

In Scrum, the user requirements are usually described by user stories. The most common format for describing a user story is: "As a [user role], I want to [do some task] to [achieve a goal]" [4]. The user stories are used to describe the requirements for the whole system being developed kept in the Product Backlog. During the Sprint planning meeting, the team, the Scrum Master and the Product Owner select the user stories that the team will work on during the next sprint in accordance to how many user stories it is possible to implement during the time of a sprint. The Product Owner describes the priorities of the user stories, so the most important user stories will be selected for the particular sprint according to the Product Owners criterias. During the daily Scrum meeting, the team members report what user stories and tasks they will be working on during the day and what the finished they day before.

2.3 User Experience

UX has gained momentum in computer science and is defined in the ISO 9241-210 in the following way [10]: "Person's perceptions and responses resulting from the use and/or anticipated use of a product, system or service". Researchers agree that UX is a complex concept, including aspects like fun, pleasure, beauty and personal growth. An experience is subjective, holistic, situated, dynamic, and worthwhile [8]. A recent survey on what practitioner's think is included in the term UX shows that respondents agreed that user-related factors, contextual factors and temporal dynamics of UX are all important factors for defining the term UX [14]. The temporal dynamic of UX also reached consensus amongst the respondents.

Many methods have been suggested for active participation of users in the software development process with the aim of developing software with good user experience. Some of the methods for focusing on either the expected UX or the UX after users have

used a particular system, including interviews with users, surveys, observations and user testing [19]. IT professionals rated formal user testing as the most useful method for active participation of users in their software development for understanding the UX of the developed system [11].

2.4 Quality of Code Including Security and Accessibility

Code quality is generally hard to define objectively. Desirable characteristics include reliability, performance efficiency, security, and maintainability [5]. Metrics to assess code quality usually include volume of code, redundancy, unit size, complexity, unit interface size, and coupling [9,1]. The process of measuring properties like complexity and the decision on what unit size is acceptable depend on the context and is often subjective.

Accessibility of web application is typically realized by conforming to the WCAG 2.0 recommendation [3]. Following these recommendation allows a web page to be interpreted and processed by accessibility software. For example, by a.o. preferring relative font sizes over absolute ones allows the web page to be rendered in any font size and making it accessible to users with visual impairments. The WCAG is seen as an important part of making web pages accessible [13].

Indeed, for any web application and any mobile application used by the public sector in the European Economic Area must conform to the WCAG [6].

3 The Case - The Financial Support RTF

Reykjavik city has decided to make the digital services easy to use for all the citizens of Reykjavik. The motivation came from two new employees that wanted to change the web services to being more user centered. One of the first projects for this attempt had the objective to make the application for financial support more usable to citizens, but to focus also on security and reliability of the code. An official request for proposals was made to select “the best” team for taking part in developing a web service in collaboration with IT professionals at Reykjavik city. One of the constraints was that the team had to follow an agile development process similar to Scrum, by using user stories, conducting daily Scrum meetings and focus on the values of agile team work and collaboration.

The teams that submitted a proposal were evaluated according minimal technical requirements and their performance and delivery after a one day workshop. There were five steps in the selection process: a) First the team submitted a proposal, b) The applying teams were evaluated according to the minimum technical requirements, c) the teams fulfilling the technical requirements were assessed according to performance criteria, d) the hourly prices of each team member were evaluated and e) the final selection of a team was decided. In this section we describe the minimal technical requirements for the teams and the three performance factors assessed during and after the one day workshops.

3.1 The Minimal Technical Requirements

The minimal technical requirements were described in the request for proposals document. The teams had to provide at least 5 team members, whereof at least:

1. Two members had to be skilled backend programmers, which had experience in writing code that was tested for security. For confirming these skills, the team members were asked to deliver a list of projects where they had worked on security issues for the system. They also had to list at least 5 software projects that they had been involved in. They had to be experienced in automated testing and have knowledge of .NET programming.
2. 1 member had to be a user interface programmer. This person had to have the experience of making apps or web services that fulfilled the accessibility standard, European Norm EN 301 549 V1.1.2 [7] that includes the WCAG 2.0 Level A and Level AA and are scalable for all major smart equipment and computers. This person had to describe his/her involvement in five software development projects.
3. 1 member had to be an interaction designer or a UX specialist. This member had to have taken part in developing at least 5 software systems, (apps or web services), with at least 100 users each. They should describe their experience of user centered design with direct contact with users and what methods they had used to integrate user in the development.
4. 1 member should have had to be an agile coach or a Scrum Master. To fulfill this, the person had to have led at least one team with at least three members with at least 10 two week sprints. This member should describe his experience regarding coaching team members.

3.2 The Workshop Organization

Five teams fulfilled the above minimum technical requirements. Each of them were invited for a one day performance workshop. The workshops took place at an office at the IT department of Reykjavik city in October and November 2018. The teams got four user stories to as possible tasks to work on during the workshop.

The user stories were the following:

1. *As a citizen of Reykjavik that has impaired intellectual ability I want to be able to apply for financial assistance via web/mobile so that I can apply in a simple and easy-to-understand manner.*
2. *As a employee of Reykjavik city with little tech know-how I want to be able to see all applications in a "employee interface" so that I have a good overview of all applications that have been sent.*
3. *As a Reykjavik city employee which is colorblind I want to be able to send the result of the application process to the applicant so that the applicant can know as soon as possible if the applicant is eligible for financial assistance.*
4. *As a audit authority for financial assistance I want to be able to see who has viewed applications so that I can perform my audit responsibility.*

The workshops were organized by a project manager at Reykjavik city. The schedule was the following:

1. The team got a one hour introduction to the schedule of the day and to the work environment at Reykjavik city, the services and systems, the organization and work practices. Also the user stories were introduced briefly.
2. The teams were asked to do a daily Scrum meeting for 15 minutes for selecting the tasks for the day and to organize the day for 15 minutes. The experts focusing on team collaboration and UX focus observed this part of the workshops.
3. The teams worked on developing their deliverables during the day.
4. The last 45 minutes of the day, the teams were asked to present to all the involved experts and the organizing team, their work practices and their deliverables. The teams could plan these 45 minutes as they preferred. They had been introduced to the performance factors that were being assessed, so some of the teams deliberately organized the presentation according to these factors.

3.3 The Performance Factors Assessed During and After the Workshops

The workshops had the goal of assessing the following three performance factors:

1. The teams collaboration and user experience (UX) focus
2. Their delivery of user stories
3. The quality of the code delivered

An assessment scheme was conducted for each of the three factors. Four external experts were asked to conduct the assessment. The team collaboration and UX focus contained four sub factors and in total these gave the maximum of 25 points. These were assessed by two external experts by observing the teams twice during the one day workshop. The delivery of user stories and the quality of the code delivered were assessed after the workshop. Two external experts in security issues and performance were asked to review the code delivered. The user stories delivered gave maximum 10 points and the quality of the code 35 points. In total these three performance factors added up to 70 points. The hourly price for the team members could give a maximum of 30 points. Experts at Reykjavik city reviewed the hourly prizes. The agile team could get 100 points in total, if they got the maximum points for all the three performance factors and the hourly prizing. We will describe the process of the data gathering for assessing the three performance factors resulting from the workshops in the next section.

4 Data Gathering for Assessing the Performance Factors

In the following we will describe the process of gathering data to be able to evaluate the team collaboration, the user stories delivered and the quality of the code.

4.1 Data Gathering for Assessing the Team Collaboration and UX Focus

Two experts in team collaboration and UX focus were asked to assess this performance factor.

Four sub factors were defined:

1. How well did the team perform at the daily meeting (max 4 points)?
2. How problem solving oriented was the team (max 8 points)?
3. How much did the team emphasize UX (user experience) (max 8 points)?
4. How well did the team present their work at the end of the workshop (max 5 points)?

The two experts observed the teams during an half an hour session in the morning, when the teams had a daily Scrum meeting and when selecting tasks for the day. The experts took notes and assessed the first sub factor. They tried to keep silent and not ask questions so the five workshops would be as similar as possible.

Forty five minutes were used as the last part of the workshop for presenting the work practices that the team used during the day and the deliverables. The two experts observed the presentation and took notes. The experts only asked, if there were issues, which the experts were about to assess, that were not mentioned during the presentation, to have better information on all the performance factors.

There was a short meetings with all the experts involved and the organizing team at Reykjavik city right after each workshop. The goal was to discuss the first impression of the workshop of that day.

For each of the sub factors there were predefined questions that the experts answered for assessing each sub factor.

For the UX emphasis sub factor, the questions were five:

- 1) Does the team emphasize UX when presenting their solution?
- 2) Does the team justify their decisions according to the needs of the users?
- 3) Does the team justify the flow and the process in the UI according to the user needs?
- 4) Has the team planned some user evaluations?
- 5) The team consulted with users during the workshop?

Each of the experts rated all the questions for the four sub factors for the teams within 48 hours and noted an argument for each of the ratings. The two experts met shortly after that assessment and discussed their individual answers to the questions and the rating of each sub factor and made a consolidated rating for the team that was sent to the project manager of the workshops. When all the teams had been assessed, the two experts met to make the final comparison of all the ratings and make the final ratings that were sent to the project manager of the workshops..

4.2 Data Gathering for Assessing the User Stories Delivered

A second team of two experts was assigned the task of assessing whether the user stories had been successfully implemented. The second team had to rely on the documentation of the submission to identify the code that was supposed to implement the feature described by the user story and the test cases for that story.

Each agile team submitted their project as a dump of a git repository. Some teams also submitted sketches, mock-ups and photographs of all documentation written down

during the workshop day. In addition, some teams kept a test instance of their system running for the two experts to test.

The assessment criteria were:

1. Did the submitting team make a claim that a user story was implemented? Lacking such a claim the experts would assume that the story was not implemented.
2. Did the submitting team document what functions were used to implement the user story? The experts would look at the code only for names that related to concepts in the user story.
3. Did the submitting team provide test cases to test the user story?

The verdict for each user story was pass or fail. The score was with respect to the maximum achieved by all teams. One team managed to implement 3 stories, which gave the maximum number of 10 points. All other teams scored a fraction of three, according to the number of stories they achieved. A finer distinction than pass and fail was rejected, because the experts could not agree on how that should be done objectively, and they felt that it was not worth the effort.

4.3 Data Gathering for Assessing the Quality of the Code

As mentioned above, each team submitted their code as a clone of a git repository. This enabled the experts to assess the way the teams were documenting their software development process.

The properties that the two experts assessed were:

1. Quality of the documentation in the code and description of code architecture
2. Quality of the log messages in version control
3. Quality of web accessibility
4. Error handling in the interface
5. Error handling in code
6. Functionality of the database scripts
7. Correct use of the model-view-controller pattern
8. Error free functionality

Both the experts and the City of Reykjavik believe that the quality of documentation of the code, the architecture, and the log messages in the version control system are predictors of product quality and maintainability of the resulting project.

Points 3 and 4 were most relevant to the interaction with the user. The experts used the WAVE web accessibility assessment tool to assess the quality of web accessibility and to check compliance with WCAG 2.0 at levels A and AA [7]. The experts investigated the choice of colors by hand and by using filters to simulate how color vision deficient users would see the web site. Overall, all submissions had some issues with web accessibility, like laying out information in the wrong order, missing alt tags for images, and so forth.

The two experts referred to the way erroneous behavior is conveyed by the user for assessing the error handling in the interface. The experts checked whether the error messages were displayed in a meaningful manner, how an encountered error would be addressed, and whether a pointer to assistance was provided.

The difference between error handling in the user interface and the error handling in the code was defined. If a possible user would make an error in using the system, or if the system would fail to perform the task the user wanted to achieve without being able to recover, the experts checked whether the error message delivered to the user provided a meaningful explanation of what happened and if it provided an assistance in how the user could recover from the error. If a possible error related to an internal API and could be handled programmatically, they considered it to be a code error. The experts expected such errors, typically thrown exceptions, to be caught, logged and handled.

Functionality of the data base scripts referred to how the data of the users was represented in the data model, how that model was represented as data base schemata, whether they were set up correctly and later used correctly.

The final parameter error free function was assessed through a demonstration of the teams, a cursory code review, and the presence of tests and their traceability to requirements.

No formal audit was defined concerning security. The assessment of secure coding standards was guided by the documents of the Open Web Application Security Project [18]. The two experts audited the submitted projects for possible injection attacks and sufficient logging and monitoring, as well as security configuration. However, ensuring security of the system and verifying that security goals have been met was outside of the scope of the assessment.

5 Results

Five agile software development teams (team A, B, C, D and E) that fulfilled predefined technical requirements were invited to take part in one day workshops. Reykjavik City wanted to assess both how the teams performed during the workshops and the quality of the deliverables they handed in. The three performance factors were: 1) team collaboration and user experience (UX) focus, 2) user stories delivery and 3) the quality of the code. The performance factors were assessed by four experts, two experts assessed the team collaboration and UX focus during the workshops, and two experts assessed the user stories delivery and the quality of the code after the workshops by reviewing the deliverables. The results from the assessment of the performance factors are shown in table 1.

Team A got the highest number of points in total for the three performance factors. This team had an interesting approach. They only focused on one user story, which was user story 1, during the workshop, but all the other teams selected more than one user story to focus on. This is why Team A got the lowest number of points for the user stories delivered. The user story that Team A selected was the only story that included the citizens of Reykjavik, the other three user stories included employees of Reykjavik city.

Table 1. The total points that each team received for the three performance factors evaluated

Performance factor	Team A	Team B	Team C	Team D	Team E
Team collaboration and UX focus <i>max 25 points</i>	25,0	12,4	9,4	7,6	19,4
Delivery of user stories <i>max 10 points</i>	3,3	6,7	6,7	10,0	6,7
Quality of code <i>max 35 points</i>	22,0	16,2	18,0	22,4	22,4
Total <i>max 70 points</i>	50,3	35,3	34,1	40,0	48,5

Team A got the highest number possible for team collaboration and UX focus. This was the only team that contacted a domain expert to understand the needs of this particular group of citizens. They called a person at the service center and interviewed her/him to enhance their understanding of the needs of the user group. One of the team members also went to the service center, which was in the same building, and tried out how the application process was during the day of the workshop. The other teams did not contact any people outside the team for gathering information on the users and only imaged how the users would behave. These teams got much lower score on the user experience focus sub factor than team A.

The results on the team collaboration factors were more similar for the teams, but still there were some differences. For some teams we did not see much communication during the daily Scrum meeting and the organizing meeting, so the team members did sit by their computers and work individually. This is against the fundamental rules of agile, where team communication and collaboration is vital [16].

The aggregate score for the quality of the code had much less variation in the rating. Teams A, D, and E received almost the same score on code quality. Each of these teams were very competent. The experts observed some differences in each of the 8 categories among these teams but the differences averaged out.

Team B did not document their code and did not trace decisions to requirements and stories. Exceptional behavior was not handled, and no tests were provided. Team C did not document parts of their code well, had many non-descriptive messages like “log in stuff” as commit messages to their version control systems, and did not take care of exceptional code paths. One error message displayed to the user was: “An unexpected error happened” and some errors were silently ignored. They aimed to implement three of the four stories, but only managed to finish two of them. Team D worked on a technical level, planning to implement all the user stories with a high standard of quality. At the same time, they chose the simplest stories. Team D and E received the same scores on code quality but aspects of code quality differed, e.g., team E had worse documentation of their process and the code, but handled web accessibility, error handling, and software architecture better than Team D.

To summarize the findings, it was surprising for all the experts how much variation there was in how the teams worked and what they delivered. All the teams included IT professionals with the technical requirements fulfilled. Team A got the job since they got the highest score of the summary of all the performance factors and their prize estimations were in line with the other teams, so they got the highest total score and the

job. They were the only team that reached out to understand the users of the service, while focusing on the code quality in parallel.

6 Lessons Learned

In this section we will summarize the lessons learned for taking part in the assessment of these performance factors.

For assessing the performance of the teams during the workshops it was essential to have the questions behind each sub factor to decide what to focus on during the assessment. Some of the sub factors were harder to assess than others. The sub factor on how the planning meeting for the day was conducted was rather straight forward to assess, since there are procedures on how a good meeting should be conducted from the literature. The experts observed, for example: if all team members were active, if it was clear who was doing what and if they prioritized the user stories. The sub factor on how problem solving oriented the team was, was maybe the hardest to assess, since there is not one activity or time frame, where this should happen. This is more like an assessment of the underlying values in the team and is therefore harder to assess.

For planning the assessment there were a lot of work done on deciding and describing the assessment criteria. This is vital in such work. A recommendation to readers that would want to conduct a similar process is to plan the assessment well and focus on issues that are valuable, but rather straight forward to assess.

Some of the technical measurements had little impact on the overall assessment. For example, the experts concluded that the commit messages had no impact on the total result. This is certainly a result of the workshop format. The experts looked at the commit messages that the teams generated during the day. Four out of five teams focused on implementing as many story points as possible. Therefore, the experts have observed the same poor quality of comments and gave the same grade. The second recommendation to readers is not to assess this factor using the work of a single day.

The quality of web accessibility was assessed. The experts concluded that this score was mostly determined by the choice of the web framework used by each team. The experts observed that little was done to provide accessibility beyond what the framework provided. In this particular project many of the users of the web solution have special needs. For this reason, we recommend to include and emphasize user stories that involve users with special needs when planning such workshops, e.g. a visually impaired user or a colorblind user. The experts commented that while this may make the teams display skills in web accessibility, this comes with the caveat that the assessment may include the same factor twice: as a technical score and as part of the story points' delivery.

Error handling in the interface was not a priority of the teams during the day either. This was surprising to the experts. Input validation was not consistently performed, and invalid inputs were too often reported in obscure ways or not at all. Cryptic error messages in English (not the language of the interface) and stack traces were displayed too often. While the experts gave low scores for this factor, they cannot recommend to ignore this.

The technical factors that had biggest impact on the selection of the agile team were the documentation in the code and error handling in code. The experts could observe

that the teams that attempted to document their architecture, the activities their system performed, and that tried to trace code to requirements produced better code. Those teams also tended to handle errors well in code, typically by logging the error and displaying an error message. Again, care has to be taken to not account a deficiency twice. The experts graded an error handled well in code even if the result was a stack trace displayed in the user interface.

A summary of the recommendations includes:

- The planning of the assessment should be done thoroughly and carefully, keeping in mind the values that the agile team should focus on during the actual project. In this particular project many of the users of the web solution have special needs. Therefore one of the sub factors assessed was the emphasis of the teams on user experience during the workshops.
- Meaningful stories should be provided to the teams that involve users with special needs. For these users the focus on accessibility and user experience is very important. Assessing the teams focus on these quality factors is vital in these cases. If the teams do not focus on the quality aspects for these users they are not likely to focus on these aspects for other users.
- If the work of a single day workshop is assessed, the assessment should include the focus on the documentation and how it manages to trace code to requirements,
- The assessment should include to check how the application handles exceptional cases and how it provides feedback to the user in exceptional cases.

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