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Jouko Nuottila
University of Oulu

Kirsi Aaltonen
University of Oulu

Jaakko Kujala
University of Oulu

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Challenges of adopting agile methods in a public organization

Jouko Nuottila

University of Oulu
Linnanmaa, PL 8000, 90014 Oulun yliopisto, Finland
www.shortbio.net/jouko.nuottila@oulu.fi

Kirsi Aaltonen

University of Oulu
Linnanmaa, PL 8000, 90014 Oulun yliopisto, Finland
www.shortbio.net/kirsi.aaltonen@oulu.fi

Jaakko Kujala

University of Oulu
Linnanmaa, PL 8000, 90014 Oulun yliopisto, Finland
www.shortbio.net/jaakko.kujala@oulu.fi

Abstract:

Agile development methods are widely used among business enterprises. Since the introduction of the Agile Manifesto in 2001, several agile methods have been implemented, first in single-team set-ups and later in larger multi-team set-ups for complex Information Technology (IT) system development. However, the adoption of agile methods has been slow in the public sector. This is also reflected in the academic literature, as there are only a few studies discussing agile adoption in public organizations. This paper contributes to research on the use of agile practices specifically in the context of public organizations, and sheds light on the challenges a public organization may face while adopting these practices. The aim of this paper is to identify and categorize the challenges that may hinder efficient adoption and use of agile methods in public IT projects that include private software vendors. This research is based on a case study of a large governmental office. As a result, this paper presents several categories of identified challenges, the root causes of these challenges, and a discussion of the characteristics of these challenges for the public sector.

Keywords:

agile methods; adoption of agile methods; agile challenges; agile barriers; agile project management; software project management.

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1. Introduction

Software development processes have evolved radically from traditional control-oriented and sequential waterfall models to today's agile development methods, the underlying principles and values of which are declared in the "Agile Manifesto" [1], [2]. Agile development methods combined with corresponding project management methods are intended to increase efficiency and flexibility in software projects and minimize unnecessary specification, administration, documentation and unproductive work [3]. Indeed, in recent studies agile methods have been proved to contribute to project success by increasing customer satisfaction and enabling flexible change management in software development, particularly within private sector projects [4]. Currently, the use of agile software procurement is gaining prominence within public sector software procurement projects. Applying agile methods in a multi-organizational public sector context requires radical changes in the way projects are negotiated, contracted, procured and organized in order to maximize created value over the project lifecycle. To date, though, only scant attention has been devoted to empirically identifying and describing the managerial challenges that may relate to the procurement and execution of agile software projects within the public sector context.

Agile methods were first implemented in small teams, projects and companies, but during the last few years the usage of agile methods has also been scaled up for use in large system development and distributed software development. However, public agencies and governmental organizations have been slow in adopting agile practices, with the exception of some specific high-tech research organizations. This situation is also reflected in academic research. Only a handful of studies exist on agile methods adoption in public organizations. Abrahamsson et al. [5] identified several research gaps in their editorial. They call for further research by stating that "with agile methods being routinized and infused in the adopting organisations, one of the most pressing issues is the need to develop a better understanding of the implementation of agile at the organisational level" [5]. Mangalaraj et al. [6] suggest in the same special issue that there are myriad issues and challenges that an organization needs to overcome to sustain agile methods. They call for research to elucidate "issues in managing the change to new and conceptually different software development approaches". Similarly, Conboy et al. [7] discuss organizational challenges in adopting agile practices and then call for further research on "the effectiveness of agile method adoption" and new research on agile project management. Furthermore, Conforto et al. [8] call for more research on agile project management and use of agile practices in software and other industries. Project Management Journal [9] also calls for more research on agile implementations and project management in different contexts. As these numerous calls for more breadth and depth of research into agile methods show, there are many topics in this area that would benefit from further study.

We found these calls for research encouraging and well-aligned with our interest in studying different forms of flexibility in projects and co-creational value in projects utilizing agile practices. Our specific interest for this paper was to study a public organization conducting software procurement with a project setup that is utilizing agile practices. Specifically, this paper was designed to investigate the kinds of challenges a public organization faces when adopting agile practices in subcontracting a software project. In addition, we wanted to gain a thorough understanding of the root causes of these challenges. To gain this understanding, we used a case study as our chosen methodology, with our chosen case being a public agency that was subcontracting complex IT system development from private software vendors. This agency's development project utilized agile methods and provided a great insight into the adoption and implementation of agile practices.

In this paper, we first review the earlier literature on the challenges in adopting agile methods. We then present the methodology and the case study setting, followed by the empirical findings. Finally, we discuss the findings and conclude with a summary of the obtained results and suggestions for the development of future research.

2. Earlier research identifying challenges in adopting agile practices

The utilization of agile practices has been rapidly increasing during the last fifteen years, and there has been a distinct change in the type of organizations using them. This change is also reflected in research on the adoption of agile methods. The first years of research focused on early adopters, single team studies and implementation in small organizations; the research focus later shifted to studying multi-team implementations and adoption in larger organizations. In our view, the current wave of studies has increasingly been focusing on the adoption of agile practices in procured and internal multi-site set-ups, off-shore implementations, and increasingly, as this paper does, on agile methods adoption in public organizations. In this section, we will briefly review the earlier studies. We will first consider the challenges that have been identified in research in small organizations and studies on early adopters, then discuss challenges in large system development and distributed software development. Finally, we will look at the few existing studies related to challenges identified in the public sector.

2.1 Challenges for small teams and early adopters

There are several studies on the challenges a development team can face while adopting agile practices. These practices emphasize the human factor in software development and agile development focuses on the talents and skills of individuals [10]. It is essential for the successful implementation of an agile approach to get customers, developers, and other involved individuals to understand their roles and responsibilities in an agile project setup [11]. Individuals must be committed to work following the agile definition of different roles as the agile setup is very much self-driven and self-disciplined [12], [13]. There can also be psychological barriers to success with agile methods. Conboy et al. [14] focused on the people-related challenges in a study with several companies and they found that some software developers fear that their possible skill deficiencies will be exposed in an agile team. This can cause social stress and resistance to agile adoption. Increased reliance on social skills and team work can also be problematic for some individuals [14]. Similarly, the agile approach is based on a different ideology than traditional methods, e.g. the waterfall model of software development and control-oriented project management [15]. For the successful implementation of an agile approach, the mindset of individuals must be receptive for agile principles to enable the organizational environment accept the agile methods [13]. Asnawi et al. [12] also noticed that it can be difficult for the individuals to adopt agile practices if they have worked with control-oriented project management methods previously. Lack of motivation to use agile methods can also be a problem; this is usually related to the fact that developers are familiar with agile practices but do not embrace the values and principles of an agile approach [14].

Prior research has identified some key issues in organizational readiness for the use of agile methods. Asnawi et al. [12] recognize that it is important to have management involvement in the transition to the utilization of agile methods. Management needs to support the changes required in the software-development-related processes in order to optimize processes for agile methods [15]. Also, management support is needed to get customer, vendor, and/or stakeholder acceptance and buy-in for using agile methods in executive-level discussions between the companies [11]. Individuals in an organization utilizing agile practices should get proper education and training in the implementation of agile methods [12], [15]. This is important not only for ensuring that the organization has enough knowledge of agile practices but also increasing individuals' understandings of how different roles work in a project organization utilizing agile methods. It is also important that customers understand their roles and participation as part of agile development [12]. Another difficulty is that developers can lack business-related knowledge regarding the system they are working for. This can be a significant issue, especially if the business owner and product owner are not working closely with the agile team [14]. In addition, a small team of developers needs to master several technology areas and have business understanding to be able to take care of the tasks they have [14].

Optimal organizational structure, project size and number of teams are widely discussed issues in agile research. Asnawi et al. [12] found empirical support for a claim that it is easier for agile practices to be adopted in small companies and teams. This idea of small teams being optimal for agile practices was supported by earlier research [10], [15]. Scholars suggest two reasons for this. First, small and startup companies have more dynamic culture which is

naturally better suited to flexible and agile practices [12]. Secondly, small companies usually do not have any legacies to follow; they have not established formal and rigorous processes yet [10], [12]. The recommendation of limiting the size of an agile organization is often linked with the importance of direct communication. Efficient communication is important when a software development project utilizes agile practices, especially because of the goal of having less documentation compared to traditional methods. There is no requirement specification done for the whole project in the beginning; typically, requirements are agreed on for the next sprint and goals, and requirements are sketched for 2-3 following sprints [15]. Developers need to get the requirements for each sprint in time and they need to understand them correctly, otherwise they might have incorrect assumptions and thus not work on what actually needs to be done [11], [12]. In order to succeed with this type of continuous discussion between the product owner and the agile team, they need to have the discipline to follow agile practices. Customers and software vendors should discuss the software development project in question and agree that agile methods are suitable for the project [12]. This does not mean that agile methods are proved not to be suitable for specific type of projects, but rather, that for the successful implementation of agile methods both parties must share the same understanding of how to utilize agile methods [11]. This also increases clarity regarding the project goals and the management structure of agile governance and decision-making. Devolved decision-making in agile team meetings can cause problems if individuals do not feel comfortable in sharing their opinions, or if the decision-making is not fair and democratic.

Knowledge transfer has been also identified as a possible challenge in an agile set-up. Agile practices promote minimizing required project documentation, and this might make it difficult to conduct a proper knowledge transfer in a situation when one or several individuals leave the team [12]. This was one of the main concerns of project managers. On the other hand, agile practices suggest ensuring that projects have high-quality and well-commented source code to make it easier for new programmers to take over. Another identified issue related to personnel management was that companies have not developed agile-specific recruitment policies or agile-compliant performance evaluation methods to support individual- and team-level abilities [14]. This makes it difficult to evaluate and educate individuals and agile teams.

As the issues listed above demonstrate, researchers have found that people-related factors and social factors are more important than the technical factors in the successful adoption of agile practices [12], [15]. There is one exception, though: communication tools are essential for agile practices if there are several individuals or teams working on a project who are not located at the same office. Agile practices are based on efficient communication, and in case of physical distance between the teams there must be efficient virtual communication tools available, and the individuals and teams should feel comfortable using them. The situation is naturally even more challenging if the teams are based in different time zones [12].

2.2 Challenges for large organizations and multi-site operations

Lindvall et al. [16] studied several large companies (ABB, Daimler-Chrysler, Motorola and Nokia) while the companies began using agile practices in pilot projects. These companies reported increased agility in pilot projects and improvements at least in one of the measured attributes: customer satisfaction; quality; productivity; and cost. Along with the positive results, the companies identified challenges and possible challenges for the adoption of agile practices. They found that the greatest challenge was not related to agile practices but to integrating agile practices into the project environment's existing processes [16]. The same issue of a possible mismatch between agile, lightweight processes and standard industrial processes was identified by Boehm and Turner [15]. Lindvall et al. [16:30] argued that "*in a large organization, a project cannot be truly independent*"; rather, each project interacts and has several interfaces with other projects, teams and processes inside the organization. This creates challenging situations, especially if one project or project team is using agile practices but other surrounding projects and teams are not.

Similar single-team implementation, it is also important to have a committed customer in a larger-scale and/or multi-site agile adoption [16], [18]. Using an agile approach, product features are defined and specified during the project. An agile team is developing features incrementally in sprints, releasing a small portion of all product features after each sprint [15]. A dedicated customer is needed to continuously identify, define, and prioritize the features to be

implemented during the next sprint(s). The customer must also continuously work together with an agile team to accept the implemented features and participate in the planning work with the team [16], [17]. In larger organizations there are usually many teams working on a single project, and thus each team must be able to communicate and coordinate with other teams. This might be challenging in an agile setup, especially if other teams are not using agile practices [16]. Teams are also often located separately in several offices and this can create communication and coordination problems as agile practices assume efficient real-time communication [5], [11], [16].

There are several challenging issues related to development processes which are typically well-defined and mandatory in large organizations and might conflict with agile practices. Agile practices encourage self-driven, self-disciplined teams to plan testing, test-cases, and quality control, but in larger organizations test case verification and quality reviews are often centralized and centrally-controlled [5], [11], [15], [16], [17]. Agile practices also usually suggest that a developer, or a pair of developers, can integrate new software frequently into the Software architecture baseline as they wish, but especially in larger systems this is controlled and monitored because there is centralized architectural control over system development [16], [17]. Agile practices assume iterative development, small releases and continuous integration. Thus, agile practices can be seen to favor new system development from scratch. Bowers et al. [17] identified some complications when agile practices were used to update and maintain a legacy system. While the agile development focused on developing and delivering small releases, there were lots of legacy interfaces and internal dependencies in the legacy system which caused many unexpected errors in the system testing [15], [17].

Agile practices very often contradict traditional quality systems in large organizations. This can be a challenge, especially if teams using both traditional and agile approaches are working on the same software system [15]. For example, formal reviews of project documentation, source code and test cases are usually part of the traditional software quality system but they are not part of the agile approach. Differences in the process can also lead to a situation of double work done, once in an agile team and then again as required in a traditional process [16], [17]. There are also other process-related implications. Agile practices promote self-disciplined decision making, feature development and integration on a team level. This should also apply to managing changes. However, in large organizations there often are change control boards for system or architectural changes [16], [17]. This might reduce the flexibility provided by agile methods and decrease the customer's perceived value of the implementation of an agile approach.

2.3 Challenges for public organizations

Studies conducted on agile methods adoption in public organizations are rare. A small number of studies, however, do touch upon the topic. Asnawi et al. [12] found that for some companies it was difficult to use agile methods when working for the government, as agile methods were not used there and governmental organizations were unfamiliar with agile practices. Kärkkäinen [19] also noted that if there is a plan to use agile methods, this should be visible in the procurement announcement by the public organization. When the project is started, there should also be a consensus between the project parties on which method will be used and how the roles will be defined and allocated [19]. There was also an organizational observation made by Asnawi et al. [12] that the personnel turnover rate was high in governmental offices, and this was a challenge for using agile methods efficiently. As these studies demonstrate, the research on adoption of agile methods in the public sector is still quite general, and more research is clearly needed.

Software is widely spread in society; the companies developing software form a big portion of project business industry [20], [21], [22]. However, a lot of challenges still seem to exist in executing software projects successfully [21], [22]. The public sector has also struggled with managing software projects; there are several reported cases of major failures in public software procurement [22], [23], [24]. The difficulties in the public sector form a fairly topical issue as governments seek to increase efficiency by digitizing their operations and providing online services based on software [23], [25], [26]. Public organizations have some characteristics which make their software procurement more challenging compared to the private companies. There is a legal environment regulating the procurement activities and related processes [27]. The government IT systems are usually very large and complex by nature [23]. The innovation speed and the pace of development are also generally slower than in the private sector [23], [26]. In addition, the lack of appropriate management has been claimed to be a salient factor that causes difficulties in public software projects [23].

Finally, it is reported that the development processes are not optimal in the public sector and thus it is difficult to estimate the received value of the projects and to get the maximum output from them [23]. There have been different approaches in research to suggest improvements for these challenges. For example, Hardy and Williams [25] have examined e-procurement software systems and Atkinson [28] analyzed how different contract models enhance software procurement. In this paper, the focus is on the adoption of agile methods in a public organization.

3. Research approach

As the knowledge related to challenges with the adoption of agile methods in public organizations is still very limited, an inductive, single-case-study approach was selected [29]. We considered the case study approach to be most suitable for the purpose of this study, as we wanted to gain a rich and in-depth understanding of the challenges in adopting agile practices in the public sector. The case study organization is a government transport safety agency which operates as an appointed commission under the ministry of transportation and communications in the Finnish government. The government agency, herein referred to simply as Agency (pseudonym), is responsible for the oversight and administration of specific area of public and private services to citizens, companies, non-profit organizations and other government offices. Agency issues permits, regulations and approvals in the transport sector. It handles transport sector taxation and registration. Agency also oversees compliance with rules and regulations governing the transport system. It has over 500 employees and manages an annual budget over 100 million euros. Agency is a large organization, but Agency's IT department has traditionally been relatively small. However, there is currently a need to deploy more resources for software projects to add to the number of online services Agency offers. To access capable resources, Agency's management has decided to increase software subcontracting, and they have also made a decision to start to use agile methods in the subcontracted projects. Agency is one of the first government offices widely utilizing agile methods, and is therefore a very interesting and suitable subject for research on agile project management in the public domain.

Semi-structured interviews were used to gain insights into informants' experiences of the adoption of agile methods in Agency, agile practices used in Agency's projects, and project management practices in agile development. The key people working on the selected project were interviewed, and several other people in Agency were also interviewed to gather background information on the decisions to adopt agile practices in Agency. In addition, a few participants in the first agile pilot project in Agency were interviewed to learn about the progress of the adoption of the agile approach in Agency. During the interviews, informants were asked to provide their background information and an overview of their experience with agile methods, and then to describe the project stages from procurement to delivery. After this, the interview focused more on the advantages of and challenges with using agile methods in the project. The interviews were done with two researchers, except for 4 instances when this was impossible due to conflicting schedules. The duration of the interviews was 50-120 minutes, and they were conducted face-to-face at the interviewees' offices between April and July 2015. The interviews were recorded (audio) and transcribed for content analysis [30]. The transcribed data was semantically complex, thus we decided to rely on human coders [30], [31]. Computer-assisted qualitative data analysis software, NVivo, was used to support the coding of the research data and facilitate data analysis. Open coding was used to identify the challenge areas, then the initial list of challenges was reviewed by several researchers; finally the challenges were grouped into the categories and subcategories presented in this paper [30]. This methodology enabled us to access rich data both from interviews and background material to analyze this case. The interviews with the representatives of the SW subcontractor also provided additional insights into the project and the adoption of agile methods. Information about the informants is presented in Table 1.

In addition to data from interviews, in this study we also used publicly available information, documentation and presentations on Agency. We also acquired internal documentation, presentations and memos from Agency to gain a deeper understanding of the adoption of agile methods inside the organization.

Table 1. List of informants.

Informant occupation	Organization	Experience (years)	Interview duration	No. of interviewers
Business Product Owner 1	Agency	> 15 years	88 minutes	1 researcher
Business Product Owner 2	Agency	> 10 years	70 minutes	2 researchers
Development Manager	Agency	> 5 years	82 minutes	2 researchers
ICT Development Manager *	Agency	> 15 years	87 minutes	2 researchers
ICT Product Owner *	Agency	> 5 years	55 minutes	2 researchers
ICT Project Manager	Agency	> 10 years	50 minutes	1 researcher
Purchasing Manager	Agency	> 25 years	120 minutes	2 researchers
Scrum Master 1	SW Subcontractor	> 15 years	86 minutes	1 researcher
Scrum Master 2	SW Subcontractor	> 10 years	54 minutes	2 researchers
SW Developer	SW Subcontractor	> 10 years	57 minutes	1 researcher

* interviewed during a single session

The project we investigated in this study is a software development project which produced a software solution for organizing and managing driving license examinations nationwide. The solution is running on a server, accessing several existing databases (e.g. exam content database and id database for candidates) and enabling remote connection by users (examination offices by computer and driving test examination officers by tablets). The software solution includes several interconnected components as it has interfaces to systems managed by other organizations and interfaces to databases (other government offices and e.g. insurance companies). Multiple user groups access the service with several types of devices. The solution is not a large software product, but it is a complex system in a dynamic environment. Agency implements Scrum as its agile method. Scrum masters and software developers are provided by the subcontractor; other project-related roles are internal ones. Agency uses a slightly modified Scrum: in addition to Scrum's default roles they have an administrative project manager and an ICT product owner for technical issues and requirements.

4. Findings

The informants from Agency were generally satisfied with the results of agile adoption in the organization and they thought that the transition to using agile methods instead of traditional software (SW) development methods was successful. In addition, they had observed remarkable improvements in the efficiency of the software development process compared to the traditional methods. Similarly, the informants from the SW subcontractor were satisfied with the project and cooperation with Agency. The positive impact of the adoption of agile methods was also recognized by Agency management. Based on information obtained from management presentations, development productivity was increased, transparency of development activities was enhanced, and relative portion of administrative work was decreased (even up to 25%). The increase of efficiency enables Agency to develop more digitized services with the

limited budget they have. This is one of the main reasons why Agency management considered agile adoption to be successful.

However, there were also significant challenges with the adoption of agile methods. Based on analysis of our data, we identified seven categories of challenges:

- Documentation;
- Education, experience and commitment;
- Stakeholder communication and involvement;
- Roles in agile set-up;
- Location of the agile teams;
- Legislation;
- Complexity of SW architecture and system integration.

Detailed descriptions of the challenges identified in the agile adoption are presented in Table 2. Illustrative quotes are also included to demonstrate the root causes of the challenges and to highlight the perceptions of the informants.

Table 2. Identified challenges in the agile adoption of Agency.

The source of the challenge	Challenge description
Documentation	One of the agile principles is “working software over comprehensive documentation” which is sometimes wrongly understood as “no documentation at all”. Furthermore, agile methods were first meant to be used and implemented in rather small and independent software projects. There are different types of requirements for documentation in a small environment compared to a large system in a complex environment. In a large public organization there is a need to share information in a much wider sense than in a small private organization. There are several external user groups for the service developed by Agency and they need documentation. Also, as the development team was remotely located, the requirement for documentation was more important, as in the case of continuous direct communication between the product owner and the team. Finding the right balance of documentation has been challenging for Agency.
<p>Illustrative quotes:</p> <p><i>Some of the feature requirements are not documented. The agile method promotes less documentation but there should be documentation on what was done and why we made the choices we made. As organization evolves and people leave, without documentation the knowledge is lost. – Business Product Owner 1, Agency</i></p> <p><i>If the vendor gets changed then where is the information of the project as the documentation is light-weighted? There lies a risk upon this... – ICT Project Manager, Agency</i></p>	

The source of the challenge	Challenge description
<i>There is light documentation on this project maybe too light, I think we should have more documentation. – Scrum Master 1, SW Subcontractor</i>	
Education, experience and commitment - <i>Organizational readiness and commitment</i>	Introduction of agile methods and their adoption was initiated by the ICT department, and other teams were only involved later. In other organizations, some people felt that the agile methods were brought in by the ICT department/management and thus that the planning and readiness was inadequate in the beginning. There were some challenges also in change management in the transfer from the waterfall approach to the agile one.
<p>Illustrative quotes:</p> <p><i>We use internal people to test the product features. While starting to use agile we didn't have as much documentation as we used to have. It caused some problems, people who started testing were confused that where are the use cases we earlier tested against. I told them we don't have them, that in agile model we have user stories instead. It was a conflicting situation. – Business Product Owner 1, Agency</i></p> <p><i>It came quite suddenly to me, the change was led by the management... by the ICT team. They wanted that we start to use agile. – Development Manager, Agency</i></p>	
Education, experience and commitment - Personnel <i>education and commitment</i>	Introduction of agile methods was started by initiating product owner trainings and trainings on agile methods. After a successful pilot project, the roll-out to all projects was started and overall agile adoption was started. Some people thought that the agile methods were introduced quickly and thus the education and training was inadequate in the beginning. This issue also relates to the ongoing service digitization activities in Agency. The activities expose more people to software development and agile methods - people who are originally coming from other business disciplines. Therefore, many people need to learn new skills in addition to their earlier area of responsibilities.
<p>Illustrative quotes:</p> <p><i>I participated in one product owner training but I was not very well trained when we started to use agile. I knew the terminology. But there were many new tools involved, backlogs and other new issues, I wasn't ready for it in the beginning. – Business Product Owner 1, Agency</i></p> <p><i>We had a training earlier but when we started with agile I had forgotten it already. Also in the beginning the scrum master at the time couldn't help us with agile methods so it was quite difficult. We couldn't manage the method in the beginning so we needed help from the agile team, what to do and when. Especially when we didn't manage all the tools yet. – Business Product Owner 2, Agency</i></p>	

The source of the challenge	Challenge description
<p>Education, experience and commitment - Agile knowledge, awareness of the method and experience</p>	<p>While the waterfall method is strongly specification- and documentation-based, agile methods rely on fluent and continuous communication, trust, and good cooperation. The waterfall method relies on a well-defined process, but agile methods build on the idea that skillful, innovative individuals and teams solve problems together by utilizing the strengths of team members and communicating efficiently. There is a major philosophical change in the transfer from the waterfall approach to the agile one, which can even require change in the organizational culture. Agency struggled with this change. One example is that previously there were several professionals who joined together to make feature specifications so it was basically a one-time effort. Now with agile practices, the specification work requires continuous involvement and this caused challenges in Agency.</p>
<p>Illustrative quotes:</p> <p><i>Good communication is the base for everything in agile. And trust. Also openness is a key thing... Sometimes we can't be sure if they really do their part in the project. We are not sure if the testing is done by the customer as it should be done. – Scrum Master 1, SW Subcontractor</i></p> <p><i>We needed to discuss through the customer with other teams. It was a rigid approach. It would've been easier to discuss directly via virtual tools. Sometimes we traveled to the same location to discuss. – Software Developer, SW Subcontractor</i></p> <p><i>The responsibilities were not clear in the beginning. However, it helped when we made the RACI matrix. – Business Product Owner 1, Agency (RACI=Responsible, Accountable, Consulted, Informed)</i></p> <p><i>The communication is really important. Some people do it naturally better than the others, the communication is important. – Development Manager, Agency</i></p> <p><i>Agile methods require good communications, there are still some challenges between the teams. – Business Product Owner 2, Agency</i></p> <p><i>Agility requires change in attitudes individually, it requires responsibility and change individually. – ICT Development Manager, Agency</i></p>	
<p>Stakeholder communication and involvement - Agile planning vs. stakeholder</p>	<p>Agency develops large IT systems which are also used by several stakeholders, usually large companies. These stakeholders use the services automatically via their own IT systems. When service interfaces are renewed or added, the stakeholders also need to plan and implement changes to their software systems.</p>

The source of the challenge	Challenge description
<i>communication</i>	There is interdependence between the software systems that must be anticipated early enough to allow all of the related organizations to make the changes needed. However, based on the agile planning principles, the interfaces may not be defined early enough to be able to communicate the interfaces to the stakeholders as early as necessary. Thus, this is a challenging issue and needs to be considered in agile projects.
<p>Illustrative quotes:</p> <p><i>We have strong interfaces to our partners and thus we can't implement all agile development methods because they need to know interface specifications beforehand. – Development Manager, Agency</i></p>	
Stakeholder communication and involvement - Flexible changes allowed by agile methods vs. stakeholder communication	As agile planning is done iteratively sprint by sprint; it is possible that some preliminarily-agreed-upon design choices would need to be changed, and the order of implementation would be changed or some features dropped. If any of these changes require stakeholders to change their implementation, it is a challenge as stakeholders will be informed late.
<p>Illustrative quotes:</p> <p><i>Sometimes when we made changes to implementation or prioritization of features it caused challenges in stakeholder interfaces as when we told them that they needed to change their implementation, then they needed to ask those changes from their subcontractors. They use waterfall development methods and it was tricky to synchronize. – Development Manager, Agency</i></p>	
Stakeholder communication and involvement - Agile processes vs. stakeholder involvement	As agile planning and specification work is done incrementally during the project, it is challenging to involve stakeholders in the planning. Also, because of the (incremental) feature release cycle, it is a complex task to involve customers and end users in pilot testing. Especially as Agency has multiple end user groups that are geographically widely spread.
<p>Illustrative quotes:</p> <p><i>We definitely would've liked to run some pilot testing for the system. There are many user groups for the system and it would've been a necessity to have different user groups testing it. – Scrum Master 1, SW Subcontractor</i></p>	
Roles in an agile set-up - Role of the product owner	There is a big change in the role of the product owner as defined in agile methods compared to traditional methods of software development. It is essential for the successful implementation of agile methods that the product owner is available to the agile team and is able to provide the team with clearly-defined user stories/requirements in a timely manner, contribute to the prioritization of user

The source of the challenge	Challenge description
	<p>stories in the backlog, and support the team when they are deciding the activities for the next sprint. This type of working pattern is new to the product owners if they are used to traditional development methods and can cause challenges in agile adoption. The product owner role was totally new to many people; they had lot of other tasks to perform simultaneously and they were not used to close cooperation with the development team. Forming such a close working relationship with a vendor was also a new way of working for a public organization.</p>
<p>Illustrative quotes:</p> <p><i>When I think retrospectively, I should have been more actively working on the backlog and following the status of implementation. – Business Product Owner 1, Agency</i></p> <p><i>Especially in the beginning, we didn't follow the agile methods well enough. At some point we realized that we didn't participate in the scrum activities as we should have been and the team was working without guidance. – Business Product Owner 2, Agency</i></p> <p><i>It requires a lot from a product owner to participate in the project in a way that scrum agile mode demands. – Scrum Master 1, SW Subcontractor</i></p>	
<p>Roles in an agile set-up - <i>Multiple interfaces of product owners</i></p>	<p>The product owner works together with the Scrum master and the agile team to take care of the responsibilities of requirement specification and prioritization. The product owner, however, collects the input from several business area owners, technical experts, legal advisors etc., so there is dependence between the contribution of the product owner to the agile team and the availability of internal stakeholders and the information they provide.</p>
<p>Illustrative quotes:</p> <p><i>Product owners are really strained and they do not have enough time to concentrate to work with the scrum team. You only meet them in the official meetings, there is no informal discussion as much as they should be in agile approach. – Scrum Master 2, SW Subcontractor</i></p> <p><i>Sometimes product owner couldn't exactly define the specification of what was needed so we implemented features based on our understanding and after the sprint demonstrated the implementation to customer to see if any changes were needed. – SW Developer, SW Subcontractor</i></p>	
<p>Roles in an agile set-up - <i>Business product owner vs. ICT product owner</i></p>	<p>Agency utilizes two product owners in agile projects: the business product owner is responsible for business requirements, and the ICT product owner is responsible for system requirements and technical questions. This approach can create confusion in the agile team on product ownership and responsibilities.</p>

The source of the challenge	Challenge description
<p>Illustrative quotes:</p> <p><i>It wasn't always clear to the agile team who to contact when they had questions. I have been working for the project as a stable resource but they also knew that ICT product owner takes care of technical issues. But maybe the roles have not been clear enough in every situation. – Business Product Owner 2, Agency</i></p>	
<p>Roles in an agile set-up - <i>Project manager vs. business product owner</i></p>	<p>Traditionally, a project manager owns the project budget, but in agile projects there is a product owner who manages the budget and uses it for the features prioritized for each sprint. Agency utilizes the model of an administrative project manager and a business product owner in agile projects which does not exactly follow the agile principles and might create conflicting situations between the roles.</p>
<p>Illustrative quotes:</p> <p><i>In the first agile project I was involved with, there were some role issues... The project manager wanted to have the ownership of the project and sometimes it was conflicting with the agile ideas. For example, sometimes the project manager didn't remember to invite the business product owner to all necessary meetings which was a problem. – Business Product Owner 2, Agency</i></p>	
<p>Roles in an agile set-up - <i>Scrum master vs. Business product owner</i></p>	<p>The Scrum master and the product owner are the key roles in agile methods and determine if the project is managed successfully. The product owner is responsible for defining what is to be implemented, and the Scrum master is responsible for the implementation. In the beginning, Agency had some challenges with the cooperation between these central roles.</p>
<p>Illustrative quotes:</p> <p><i>At first, the scrum master didn't manage or didn't implement the agile methods in the most optimal way. We didn't have enough experience of the agile methods and the scrum master didn't implement them and the situation hindered the project progress. – Business Product Owner 2, Agency</i></p>	
<p>Location of the agile teams</p>	<p>Agency also has experience on a project in which an agile team and a Scrum master were working remotely from a separate location. Although virtual communication tools were available, it was difficult to organize the agile development remotely, and the cooperation was not on the same level as the co-located teams.</p>
<p>Illustrative quotes:</p> <p><i>We ended up in a virtual project world. We could operate like that, there were no major problems, but it is not as good as having all in the same location. – Scrum Master 1, SW Subcontractor</i></p>	

The source of the challenge	Challenge description
<p><i>Let's say that some issues would have been easier to organize if the team was located here. Communication can be organized via tools, chats etc. but it is not the same as sitting in a same room with the team when there are things to discuss. – ICT Product Owner, Agency</i></p>	
<p>Legislation - Public procurement act</p>	<p>Finland's public procurement act regulates what kind of data on companies (in preparatory bidding and competitive dialogue) can be used, and how it can be used to evaluate the companies. For example, it is not possible to use the formal or informal positive track record of a company as a reference in competitive procurement. Past experience of cooperation or personal opinions cannot be used either - only the documents and discussions presented during the bidding can be used for evaluation of companies. There is one exception: if a company participating in the bidding has worked as a vendor for a public office, a record of reclamations and notices of defects can be used as a negative reference. However, this type of record is available only for two years prior; older incidents cannot be used. The objective of the public procurement act is to guarantee a fair and neutral position for all companies participating in the bidding. Any possible long-term relationship between Agency and its vendors cannot put any vendor in a favorable position in the procurement process. However, as successful implementation of agile methods builds trust and good dialogue between organizations, this type of legislation can be a hindrance for the most optimal vendor selection.</p>
<p>Illustrative quotes:</p> <p><i>Some of the big companies are professionals of making bidding documentation; they have lots of experience on it. They have experts on writing bidding documents and they know how to answer all the questions by the customer. Sometimes when you read those documents and you compare the data to your own experience on how those companies work in practice you can see some conflicts between the documents and the real project work by them. But it is impossible to use your experience or history knowledge on the evaluation; you can only use the documents. But that's how it goes, you only have to live with it. – ICT Development Manager, Agency</i></p>	
<p>Legislation - Information sharing</p>	<p>There are also some peculiar consequences for project implementation because of the public procurement act. In the worst case, it prevents information sharing to all stakeholders as would be necessary. This is a challenge as agile methods are based on open communication and information sharing.</p>
<p>Illustrative quotes:</p> <p><i>There was a plan to collect more information from stakeholders but as one of them was going to participate in the next competitive procurement, we couldn't share this issue with them. – Business Product Owner 1, Agency</i></p>	

The source of the challenge	Challenge description
	<i>We couldn't share all the information with the stakeholder as they could've got competitive advantage to the next competitive procurement. – Scrum Master 1, SW Subcontractor</i>
Legislation - Timing of new legislation	Agency also develops new or updated digital services which are based on new or changed legislation. There is a predetermined date when laws come into effect, and any corresponding digital services need to be available immediately. This sets a target date for a software project, as it usually was set for a project utilizing the waterfall development method. However, agile methods usually use continuous integration, and this difference in approaches can affect agile project dynamics.
<p>Illustrative quotes:</p> <p><i>After a sprint, we release features to the development environment. They will wait there until the date when the law comes to effect. In that sense, our approach is somewhere between the agile and the waterfall. – Development Manager, Agency</i></p> <p><i>You need to consider when the law comes to effect, in a sense it limits the options for a product owner, it sets a schedule for the project. – ICT Development Manager, Agency</i></p>	
Complexity of SW architecture and system integration - Complexity of SW architecture	Agency develops digital services that a) have several user groups in the market, b) integrate with several backend systems and databases, and c) are developed by several teams. Technically, this means that the software architecture of those services is complex and has many interfaces and integrations. As agile methods were originally meant for rather small and isolated systems, the complexity of developed systems causes challenges in agile adoption.
<p>Illustrative quotes:</p> <p><i>It has been quite challenging, while implementing features with agile, we always need to think what are the other systems affected and what is the impact. – Development Manager, Agency</i></p> <p><i>Backend systems are developed by other teams. It is challenging to take into account all the backend systems and databases. – Business Product Owner 2, Agency</i></p> <p><i>There are backend systems we only use through interfaces while we develop our service. It is a bit challenging for example when planning performance and performance testing. – Scrum Master 1, SW Subcontractor</i></p>	
Complexity of SW architecture and system integration - Complexity of system integration	Agency develops digital services and complex systems by subcontracting software projects. These services also use other backend systems and databases which were developed earlier. The integration of separate systems is done through technical interfaces. Agency does not maintain the existing systems and databases but uses

The source of the challenge	Challenge description
	subcontracted resources for maintenance, repairs, and upgrades. Agency is coordinating these development and maintenance activities. With complex systems there can be several companies involved with bilateral contracts with Agency and with bilateral service level agreements regarding the implementation of changes and upgrades needed for the systems and interfaces. This kind of complex environment is challenging for agile methods, which promote continuous and instant release and integration.
<p>Illustrative quotes:</p> <p><i>We have had big problems with our system integration environments. It kind of made it impossible to follow the scrum cycle. – Business Product Owner 1, Agency</i></p> <p><i>Agile adoption reflects the organizational capabilities in my opinion. After we got teams working ok, we faced problems with technical infrastructure and system integration. – ICT Product Owner, Agency</i></p> <p><i>We have had problems with the system integration. For example we couldn't provide the agile team with a possibility to continuous release and integration as the assumption is with agile methods. – ICT Project Manager, Agency</i></p> <p><i>The system integration and interface management has been difficult. For example, a while ago our integration interface to a backend system just stopped working. After a while we realized that it was changed but we were not informed at all. – Scrum Master 1, SW Subcontractor</i></p>	

5. Discussion

The adoption of agile methods was considered to be successful by the management of Agency. This assessment was based on the measurable metrics inside the organization. Despite this, we identified several major challenges in the agile methods adoption. Some of the challenges are, as expected, similar to the ones recognized in prior literature. However, some of the challenges we identified are particularly unique to public organizations.

Finding the optimal balance between formal documentation and informal communication was difficult for Agency. This challenge is related to the conflicting objectives of the waterfall and agile methods. The emphasis of the waterfall approach is to specify a project in detail while one of the founding values of agile methods is to focus on working software over comprehensive documentation [32]. This principle of agile practices is sometimes wrongly interpreted as a goal of minimizing documentation. This finding was also supported by earlier research in the private sector [12], [14]. The documentation challenge was even more serious in Agency, as in public organizations heavy and detailed documentation has traditionally been one of the most salient requirements and expected ways of working.

Personnel education is identified as one of the key tasks for ensuring the successful adoption of agile methods [10]. There was formal training organized by Agency, but it was not enough to make personnel feel that they fully grasped the method and required practices and had the necessary competencies. According to our analysis, this was one of the reasons there was a lack of commitment, especially in the beginning of the project. Conboy et al. [14] argue that formal

training is not enough; people should understand and learn agile values and principles in addition to practices to be motivated and committed. Murphy and Cormican [33] similarly argue that the psychological motivators play a significant role, together with abilities to cope with and manage change, in adopting new technologies and methods. These issues relate to role definition in agile methods, which is different compared to the waterfall method and traditional project management styles [15]. In the case of Agency it was clearly a challenge for some individuals, e.g. product owners, to embrace the roles and responsibilities of agile methods, and this hindered the efficient adoption of agile practices. In addition, Agency implemented a modified version of Scrum, which included an administrative project manager. The existence of multiple and overlapping roles possibly increased the confusion between the old project management model and the agile one. Clear roles are identified to be essential for successful agile implementation [15]. Similarly, the social skills of individuals and well-established social relationships in the project facilitate the problem solving that is so important for an agile approach [14], [34], [35]. Lack of direct communication in the case project was also seen as a barrier for the efficient usage of agile methods. These human-related factors reflect the fact that individuals and organizations need to change their ways of working when they start to adopt agile practices. Moe et al. [36] argue that this change requires a reorientation by project personnel and management, and they add that this change takes time and resources. Our findings support their claim, as the people-related issues comprised the largest single category of challenges in this case study. In Agency, as in many public organizations, there was an established formal mode of operation, which created a challenging environment for adopting agile methods. Consequently, a public organization might even need to revisit its underlying organizational values and culture to be able to adopt agile methods successfully.

Legislation caused challenges in agile adoption in two separate ways for Agency. The first one is specific to the case study organization, although it may represent a problem facing many governmental organizations. Public agencies must develop IT systems for implementing digital services for a public audience. Some of these public services are related to legislation, such as tax legislation, and they need to reflect any changes to the existing legislation. Therefore, the date when a change in a law comes to effect sets a deadline for the project, which conflicts with agile methods. The other challenge in terms of legislation relates to the public procurement act. To guarantee that all companies participating in bidding will be on an equal and impartial basis at all stages, the public procurement act dictates a code of conduct for public agencies regarding bidding. In some specific issues this can restrict the possibility of a public agency acquiring and using all information available, and it can also restrict the possibility for early discussions with companies in the market. Currently, there are some calls, specifically on the European Union level, to revisit regulations regarding agile procurement to address this current situation.

Technical issues can also hinder the adoption of agile methods. Agency faced severe challenges in integrating the software architecture of several related systems with the newly-developed one, and they had difficulties following agile practices to enable continuous integration of sprint releases. These issues lend support to the findings of earlier studies [15], [16], [17]. In our case study and also in earlier research, these problems largely relate to the external environment of the project. In many cases, stakeholders and organizations managing other internal systems are not informed, prepared or committed to support the agile development and related demands. This also relates generally to stakeholder involvement, which may be challenging with an agile approach, especially if the stakeholders are used to following traditional software development processes [15]. Consequently, it requires extra efforts in planning, communication and alignment to synchronize organizations utilizing a traditional development cycle with those using an agile approach.

A public agency generally faces similar challenges in agile methods adoption as private organizations do; however, there is additional complexity related to those challenges because of the characteristics of governmental organizations. A unique finding of this study is that governmental regulation of procurement procedures can introduce more challenges in the adoption of agile methods compared to the private sector. Also, technology dependence on external systems as a hindrance of agile method adoption is rarely discussed, although it must be addressed in large system development.

6. Conclusions

In this paper we presented our findings on the challenges in the adoption of agile methods in a governmental organization. The identified challenges were related to a) documentation, b) personnel education, experience and commitment, c) stakeholder communication and involvement, d) roles in an agile set-up, e) location of the agile teams, f) legislation, and g) complexity of SW architecture and system integration. This research has a few limitations that may present opportunities for further research. As our research was conducted as an exploratory, single case study, further empirical research is needed. It will be important to verify and extend our findings, especially when public software procurement is continuously increasing. We think that it would also be important to have more research specifically on the relationship between the aforementioned challenges and agile project management, as our focus was on the challenges, not on the practices of project management required for agile methods. We would also suggest more research on the management of projects utilizing agile methods. Especially interesting is the evolution from traditional project management into the concept of agile project management. In addition, more empirical research is required on the project role definitions in an agile setup, and the agile forms of organizing in the public sector.

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Biographical notes**Jouko Nuottila**

Jouko Nuottila is doctoral student and researcher in Industrial Engineering and Management at the University of Oulu. His primary research interests lie in studying the forms of flexibility in project contracting with a particular interest in agile development methods and agile project management. He holds an MSc in Industrial Engineering and Management. He has industrial experience in technology marketing and software product management at Nokia Corporation.

www.shortbio.net/jouko.nuottila@oulu.fi

**Kirsi Aaltonen**

Kirsi Aaltonen (Dr. Tech) is Assistant Professor of Project Management at University of Oulu, Industrial Engineering and Management in Finland. Prior to that she has worked as Senior Lecturer at Aalto University in Finland. Her current research interests are in areas of stakeholder and uncertainty management in large and complex projects. Her publication list includes more than 40 academic papers and book chapters in the area of project business. She has published for example in Scandinavian Journal of Management, International Journal of Project Management and International Journal of Managing Projects in Business.

www.shortbio.net/kirsi.aaltonen@oulu.fi

**Jaakko Kujala**

Jaakko Kujala is Professor of Project and Quality Management at University of Oulu. His current research interest include simulation as a research method, stakeholder management in the project business context, governance of complex project networks with specific focus on collaborative project delivery methods such as agile and project alliancing.

www.shortbio.net/jaakko.kujala@oulu.fi