Systematic Literature Review of Agile Framework Application for IT System Development in Public Sector

Jolanta Graudone [1], Mārīte Kirikova [2]

[1,2]Riga Technical University, Ķīpsalas iela 6A, Riga, LV-1048, Latvia

Abstract

Agile methods support an iterative, communication based and flexible way of IT software development that reduces the traditional software development risks. This paper addresses the aspects of Agile application in public sector that is seen challenging and still lacks enough knowledge and practice to be addressed in the formalized way. A systematic literature review was done with the aim of providing insights into the most critical aspects highlighted in the related work by mapping these aspects over the project lifecycle phases thus giving a broader view on the problem in general; furthermore interrelated aspects are discussed on the basis of existing suggestions and practices from other studies. Collected solutions could help researchers and practitioners to resolve some of the issues of Agile application in IT development in Public sector.

Keywords

Public sector, software development, project management, Agile.

1. Introduction

With creation of Agile manifesto in 2001, the formal approach to mitigate and address the most common IT development challenges of that times was created. Even though Agile approach was widely used in private sector, the public sector [14], because of several specifics existing in these organizations, are still often using the traditional ways of working and that also applies to the IT development [15]. The Agile presents many benefits but the conflict with public sector regulations, organizational structure, and other characteristics has slowed down, or in some cases stopped, the introduction of Agile [15].

There are many real-life examples that have shown that it is possible to introduce Agile practices and get benefits from them in public sector, but Agile also brings new risks and challenges that need to be addressed [5]. Considering the high complexity IT systems and the problems in availability requirements, and the scale of the systems that are needed in governmental organizations [16], it is understood that the iterative approach, business value prioritization and the constant communication facilitated by Agile practices is the key to ensure success of these projects [13], [14]. And, by addressing the challenges of Agile application in the public sector, it is possible to help ensure the benefits of Agile that it brings [7].

2. Research methods and data collection

To address research questions systematic literature review was done. For the literature review the articles of last 6 years were considered based on the high increase of digitalization processes in public sector organizations, especially in period of 2016 – 2022 that would also include the latest tendencies in the IT system development field. There is not much research available on Agile practices for software development in public sector. The articles provided by search engines using such keyword combinations as "application of agile in public sector", "challenges with Agile in public sector" in Scopus database provided 34 and 56 results respectively, from which approximately 70 % were

2nd International Workshop on Agile Methods for Information Systems Engineering (Agil-ISE), June 2023, Zaragoza, Spain
EMAIL: Jolanta.Graudone@rtu.lv (A. 1), Marite.Kirikova@rtu.lv (A. 2)
ORCID: 0000-0002-9369-3744 (A. 1), 0000-0002-1678-9523 (A. 2)

relevant, similar results were achieved in databases of Web of Science with less results but the same distribution. From all articles those found the most relevant were handpicked, that were relevant in topic of outsourced (contracted) software development and risks, challenges that are related to working under Agile framework.

The selected articles could be grouped by the type of research method applied. Most of articles consist of a specific country case studies [1], [2], [3], [4], the second group is the research that considered several or one case in sample area, using surveys, interview, questionnaires [5], [6], [7], [8], the last group, [9], [10] is systematic literature review articles.

The main aspects of the Agile application in public sector will be identified based on the analysis of related work. An aspect is understood as an area of improvement, challenge or risk in Agile application that is significantly contradicting to the traditional ways of working and organizational characteristics existing in public sector.

The research questions of this paper are:

1) What are the most contradicting aspects of Agile application in public sector IT development projects?
2) Is it possible to observe interrelations between several contradicting aspects?
3) What are the improvement suggested for addressing the aspect contradicting the traditional ways of working in public sector?

The goals of this analysis are by addressing the research questions to, firstly, detect the scope within the IT development project where the contradictions exist, and, secondly, to investigate the interrelation of aspects and elaborate more on group of aspects that, if being resolved, could improve the Agile practices in public sector.

As there is a limited amount of research work in the topic of interest, this analysis gives a new uniform view on the already presented information that has been provided as success factors, challenges and risks (aspects - previously defined) while also considering interrelation between them.

3. Contradicting aspects of Agile and tradition project management practices in the Public sector

To provide and organized and clear view on information available in related work and to determine the most problematic phases and aspects of the Agile practice application in projects developing IT systems for the public sector, each, even small, area of elaboration in any source used was (1) identified, (2) grouped by commonalities, and (3) mapped to 5 phases of project lifecycle. The results are shown in Table 1. The five phases of project lifecycle are chosen according to PMBOK Guide [11]. Each of the phases have defined content and activities to be performed that were cross-referenced with the activities and characteristics highlighted in the analysed articles.

Table 1

Mapping of Agile application aspects to Project lifecycle phases

	Aspects considered in related work																	
	Initiation				Planning				Execution				Monitoring and control			Close		
	Organizational hierarchy	Innovation and business case	Contracting	Evaluation of potential contractor	Scope and price	Project plan	Roles and responsibilities	Risk management	Practices and Scrum	Collaboration and communication	Business and IT team alignment	Knowledge and skills	Progress monitoring	Feedback	Change management	Delivery	Documentation	Evaluation of project
Reference	[2], [10]	[6], [7], [10]	[1], [2], [3], [7], [8], [10]	[3], [8], [9]	[3], [6], [8]	[1], [2], [3], [4], [6], [10]	[3], [6], [7]	[2], [5], [9]	[1], [2], [6], [7] [8], [10]	[2], [4], [5], [6], [7]	[2], [3], [4], [5], [8], [9]	[4], [7], [8], [9], [10]	[1], [6]	[1], [4], [8]	[2], [3], [4], [5], [6], [7], [8], [9], [10]	[2], [4], [5]	[6], [7]	[1]

3.1. Initiation

The challenges that are related to the **organizational structure** can be linked with several project lifecycle phases. In its essence this challenge is related to the differences in the organizational structure that is usually existing in public sector. Agile principles manifest the teamwork and collaboration and most importantly self-organization that conflicts with the hierarchical structure, control and command approach in organizations of public sector [10].

Innovation and adaptation process in public organizations is also discussed and found to be slower than in the private sector that could rise some difficulties to start project and determine the **business use case** [6], [7], [10].

The major issue discussed in [1] is the **contracting** of IT system development services. In public sector, the public procurement law, especially in EU countries, adapted from EU legislation [12], limits the organizations of applying a flexible scope, options of changes in requirements, budget, or project plan as it should be set prior as required by procurement regulations [3] , [10].

The procurement limitations rise another issue related to the evaluation process of possible vendors and **choice of contractor** [3], mostly it is question of the lowest bid that not necessarily is the best way to choose the partner for system development and that also rises another problem — the lack of trust [8], [9].

3.2. Planning

The public sector software acquisition method through procurement defines that the **scope and price** of the software development is fixed, as the requirements need to be set before the tender and it directly contradicts with Agile that manifests the flexible scope [3], [6], [8]. The specification of the system being developed should be presented at the start of the tender process and cannot be changed if special conditions are not foreseen. From legal point of view that is also emphasized in article [1]. Contractor is providing the cost offer based on presented requirements that as in any initiation phase are still under limited to the current understanding [8]. Accurate definition of requirements is important, but cannot save from external impact and complexity risen effects on software requirements.

The research results of [6] show that the second most common challenge of agile application in public sector is the planning and initiation of the project. But for cases where agile is applied, on the opposite to all benefits, it is reported that the predictability of the project is reduced [10], [2], that is not well perceived by public organizations. Together with the fixed scope and price, at the start of the project the **project plan** is determined, and go-live date is set based on assumption that the scope and cost is not changed. The principle of *magic triangle* of project management manifests that these three aspects (scope, price, time) are closely linked and changing one of them leads to changes in others. In practice, usually, these are not fixed values leading to overstepping of one or another aspect and risking with a very low-quality result [1], [3], [4].

Setting **the roles and responsibilities** is important for successful project management and execution and should be agreed between parties prior the active development phase is started. The authors of [3] suggest defining roles and responsibilities in agreement between parties, in other sources more traditional roles in Agile are discussed. Different setups exist, but the problem with public sector is the lack of *knowledge* about agile practices leading to not understanding of the role assigned [6], [7] and low dedication of organization's employees assigned to project, as it is, most commonly, an additional responsibility to everyday tasks and is not properly respected by the organization [7].

Especially with high complexity projects, the **risks** of not meeting the goals of the project increase. Even though the Agile software development covers most of the IT critical success factors, there is still a need for continuous identification and analysis of risks [5]. The research presented in [3] emphasizes the need for early risk estimation by client and dividing of responsibility of risks between parties. Early identification and mitigation of risks reduces the need for costly mitigation afterwards [9].

3.3. Execution

To facilitate agile type of development different **practices** in public sector have been adopted. Most of them are associated with successful project. The practices covered in more than one of the articles are summarized in Table 2. Controversially to the benefits of client involvement, the authors of [5] report about risks of technical debt and not meeting non-functional requirements in case of too high involvement of a business side increasing the pressure on development team on delivery of new functionalities. The practices also mostly contradict the usual way of working in different public organizations. The **Scrum** is one of the Agile based methodologies that is most commonly applied in the public sector to facilitate agile practices [2], [6].

Traditional risk of development is poor **communication** with users and stakeholders, which is mitigated by Agile practices [2], [4], [5]. The adaptation of communication practices is challenging as the public organizations usually relay on thorough documentation and indirect communication [7]. Also, the communication and collaboration are important between development teams [6].

Specifically in Public sector, where requirement list is set at the start, there are cases where the dispute between Business and IT teams is caused on the specifics of the requirement, business side is trying to include more than expected, but the IT side is trying to provide minimum of what is required [8]. The mutual understanding of the tasks can be a challenge. Most of research describes Agile practices to improve the **alignment of Business and IT teams** [2]−[5], [9].

Appropriate **knowledge and skills** are a challenging aspect across all the participants, but most problems arise in the public organizations, as the client competence contributes to success of the project [4] as well as of other stakeholders and users. The problem may arise if stakeholders are not familiar with Agile practices and their own roles and responsibilities [8]–[10]. Even with training, it can still cause issues in the practice [7].

Table 2
Agile practices in public sector

Practice considered in more than one article	Reference article indication						Number of articles
	[1]	[2]	[4]	[5]	[6]	[8]	
Estimation	x	x	x		x		4
Daily stand-up		x				x	2
Frequent delivery		x	x				2
Short iterations		x		x			2
Iteration and release planning		x		x	x		3

3.4. Monitoring and Control

The **progress monitoring** in article [1] is related to contractual relationships of parties, providing insights of public sector and need for monitoring result reliant payment and planning methods. On other hand, the authors of [6] present the Scrum methods for monitoring of each sprint with progress report.

In Agile the frequent deliveries with short time-boxed iterations enables the possibility to receive **feedback** continuously and assure that the functionality implemented matches the needs of business [2], [4]. The availability of this feedback, more or less, relies on the involvement of client, other stakeholders, and users in the testing of provided functionality [8].

Change management is facilitated within the Agile framework but is clearly contradicting the traditional ways of project management in public sector (because of early set requirements and fixed scope and price). Flexible scope within Agile is a huge benefit in dynamic environment and complex systems and is widely elaborated in the articles used in analysis of Agile approaches [2]–[8], [10].

3.5. Close

The authors of [2] report that reason for implementing Agile is the **delivery** predictability, which is interestingly contradicting the project predictability that usually is evaluated as decreased. Delivery to user is not an aspect that is resolved within the framework, but also it does not contradict the traditional

project management in public sector [4], [5]. In the [5], an example is provided where dedicated sprint for dealing with deployment and operability issues was introduced to improve the situation.

Documentation in public sector has a much higher importance than it is positioned in Agile practices and methodologies based on Agile that can arise some challenges within the public organization [6], [7].

Evaluation of a project is mentioned in [1] as a basis for the settlement with contractor, but in general, the whole project with all involved parties can and should be evaluated regardless of the applied development method.

4. Analysis of ways of handling interrelated Agile application aspects

Clearly not all activities of a project lifecycle are represented in each phase, but it is safe to conclude that these are the activities and aspects that are already identified in previous research to be significant for success of the project and most importantly, in this specific case with Agile practices, in the public sector.

From analysis it is possible to conclude that seven of the aspects were mentioned at least in the half of the articles reviewed, these are mostly connected to the execution of the project, where the actual development takes place. That also could be an indicator that, even if the public organizations are not working with Agile principles in their usual business, it is still explored how this could be applied in the execution phase exclusively for IT system development projects.

By looking back on the summary provided in Section 3, it is possible to indicate at least one group of interrelated aspects. If considering public organizations applying Agile, there is a strong interdependency between practices applied, collaboration and communication, roles and responsibilities, knowledge and skills and organizational hierarchy that can be concluded from the summary of the aspects collected and the commonalities of issue representation in the related work.

4.1. Collaboration and communication

This is one of the main attributes associated with Agile ways of working. The questionnaire results reported in research in Brazilian public sector [2] show that more than 80% of respondents have responded that the Agile practices have improved the collaboration and communication within and among the teams that is also the aspects evaluated to be improved the most. The authors of [9] categorize collaboration and communication issues under the cultural change category. Although, the high elaboration on the issue effects on project and its importance are present in several of reviewed articles, none of them provide clear suggestions to facilitate better collaboration and communication. But from the Brazilian research results it could be speculated that the Agile itself is the main solution and some practices within the Agile approach should be more strongly followed to gain improvements.

4.2. Roles and responsibilities

On the roles and responsibilities aspect the research [7] on Finnish government organizations IT projects with Agile approach has provided several insights. In the research semi-structures interviews were conducted with participants and the results were structured and analyzed. In the results, roles and responsibilities were one of the categories of challenges. As of outsourced software development and organizations structure, some additional roles were included in the framework, e.g., business product owner and ICT product owner, and administrational project manager that caused additional confusion about responsibilities, but reduced the risk of incompetent participant in the role in some cases. They also emphasize the work-load of a product owner: as nominated from the organization, it was a big shift in the amount of work they needed to deal with in comparison to traditional project management causing insufficient communication possibilities because of overload. In conclusions the authors connect the issues with organization structure also and provide suggestion to manage it with the change in organization values and culture, while the participants suggest better training to be ready for Agile [7].

4.3. Knowledge and skills

Lack of knowledge and skills is identified as a challenge in several articles. It can be divided in the knowledge and skills in Agile practices and knowledge [3], [4], [7], [9], [10] and skills necessary for development of system under the question. From the latter one, development team's lack of knowledge about operations is highlighted, and also the unwanted effect of new teams that usually cause more defects [5]. The need for Agile knowledge once again justifies the necessity of Agile training. Some suggestion is presented in already mentioned Finnish organizations research [7], where participants respond that the communication is the key to overcome the lack of knowledge, in some responses they mention the valuable contribution of RACI matrix.

4.4. Organizational hierarchy

The Agile approach is more suited for organizations that are not hierarchical and using command and control type of work process. [2]. The research about Brazilian government identifies this as a risk and applying Agile ways of working includes under the cultural change challenge [2]. In literature review done in [10] it is also indicated that, regardless the benefits of Agile, it does not guarantee success in hierarchical organizations. Authors suggest that the management should show the initiative in cultural change giving an impulse to employees to shift from individual to more collaborative way of working. With management involvement in cultural change together with well-defined roles and responsibilities within project there is a way to minimize the risk of organizational structure impact.

4.5. Practices

Practices in Agile realization differ but, as previously stated, the Scrum methodology, together with all the practices coming with it, is the most popular within public organizations. The limitations of contracting are provided in research of Agile practices in public sector in Italy [1]. The authors are suggesting using the estimation as one of practices not only for sprint planning but also as a reference for payments for delivered functionalities in result creating a specific contract framework. Additionally, the practices as such include not only the processes but the roles already mentioned. Different approaches exist here, for example, [7] suggest creating several product owner roles but, as for [3], to create a team that collectively represents the product owner.

5. Conclusions

By search of related work, it is evident that there is still a lack of appropriate level of understanding of the practices of Agile application in public sector and many challenges to be faced that calls for appropriate in-depth research. The Agile application impacts all of the project lifecycle phases and, even though it is mostly discussed in the execution phase, the linkage and impact to all other project phases should be considered.

From suggested solutions to manage these aspects, the common one is the cultural change that needs to be undergone to implement the Agile practices because of the hierarchical structure in public organizations, command and control way of working, high documentation level and formal ways of communication that contradict the Agile practices in different ways. From more practical perspective, a strict role and responsibility definition was suggested that should also be effective to manage identified aspects. The importance of appropriate knowledge is stressed and calls for a need of appropriate Agile training in public organizations that can significantly improve the project success.

In conclusion, there is still a need for more in depth analysis of the aspects identified to see how Agile in the public sector practically could be improved as the information on the Agile practices in the public sector is still limited, but development of complex IT systems in the public sector is still problematic and that could be resolved with application of an appropriate Agile framework.

6. References

[1] D. Russo, G. Taccogna, P. Ciancarini, A. Messina, and G. Succi, "Contracting Agile Developments for Mission Critical Systems in the Public Sector," in Proceedings of the 40th International

Conference on Software Engineering: Software Engineering in Society, 2018, pp. 47–56. doi: 10.1145/3183428.3183435.
[2] R. M. Fontana and S. Marczak, "Characteristics and challenges of agile software development adoption in Brazilian government," Journal of technology management & innovation, vol. 15, no. 2, pp. 3–10, 2020.
[3] A. KACZOROWSKA, "Traditional versus agile project management in public sector in Poland," Scientific Papers of Silesian University of Technology. Organization and Management Series, vol. 2020, no. 149, pp. 287–302, 2020.
[4] P. Mohagheghi and M. Jørgensen, "What Contributes to the Success of IT Projects? Success Factors, Challenges and Lessons Learned from an Empirical Study of Software Projects in the Norwegian Public Sector," in 2017 IEEE/ACM 39th International Conference on Software Engineering Companion (ICSE-C), 2017, pp. 371–373. doi: 10.1109/ICSE-C.2017.146.
[5] A. Elbanna and S. Sarker, "The Risks of Agile Software Development: Learning from Adopters," IEEE Softw, vol. 33, no. 5, pp. 72–79, 2016, doi: 10.1109/MS.2015.150.
[6] A. Ribeiro and L. Domingues, "Acceptance of an agile methodology in the public sector," Procedia Comput Sci, vol. 138, pp. 621–629, 2018.
[7] J. Nuottila, K. Aaltonen, and J. Kujala, "Challenges of adopting agile methods in a public organization," International journal of information systems and project management, vol. 4, no. 3, pp. 65–85, 2016.
[8] Y. Lindsjørn and R. Moustafa, "Challenges with lack of trust in agile projects with autonomous teams and fixed-priced contracts," in ACM International Conference Proceeding Series, 2018, vol. 147763, pp. 1–5.
[9] B. Shahzad, K. M. Awan, M. Ikram-Ullah Lali, and W. Aslam, "Identification of Patterns in Failure of Software Projects," Journal of information science and engineering, vol. 33, no. 6, pp. 1465–1480, 2017.
[10] I. Mergel, Y. Gong, and J. Bertot, "Agile government: Systematic literature review and future research," Gov Inf Q, vol. 35, no. 2, pp. 291–298, 2018, doi: https://doi.org/10.1016/j.giq.2018.04.003.
[11] The standard for project management and a guide to the project management body of knowledge (PMBOK guide)., Seventh edition. 2021.
[12] "Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC," European Parliament, European Council, Jan. 01, 2022.
[13] K. Beck et al., "Manifesto for Agile Software Development," 2001. Retrieved March 6, 2023, from http://www.agilemanifesto.org/ .
[14] J. L. Cooke, *Agile: an Executive Guide : Real Results from IT Budgets*. Ely, UNITED KINGDOM: IT Governance Ltd, 2016. [Online]. Available: http://ebookcentral.proquest.com/lib/rtulv-ebooks/detail.action?docID=4519661
[15] A. Ribeiro and L. Domingues, "Acceptance of an agile methodology in the public sector," *Procedia Comput Sci*, vol. 138, pp. 621–629, 2018, doi: https://doi.org/10.1016/j.procs.2018.10.083.
[16] K. Balka, B. Heslin, and S. Risse-Tenk, "Unlocking the potential of public-sector IT projects," *McKinsey & Company*, 2022.