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The overarching purpose of the research described in this report, which is based on a research project financed by the Concept program (with resources from the EDOS centre providing additional resources to extend the data collection and analysis¹), is to provide evidence-based advice for a more effective front-end phase, enabling good governance in the execution phase, when using agile methods in IT development of new products and services in the public sector.

To achieve this purpose, we attempt to answer the research questions:

- What is done in the front-end phase of agile IT development of new products and services?
- What are the connections between what is done in the front-end phase and how the IT development progresses?
- How should the front-end phase of agile IT development be conducted?

The front-end phase here refers to the part of IT development that starts with the identification of needs and ends where the actual development of the software begins. Examples of activities done in this phase are analysis of needs, requirements analysis, concept evaluation and selection, cost estimation, calendar time estimation, benefit estimation, socio-economic analysis, preparation of a business case, development of a plan for the execution of work, and budgeting. In the State Project Model (statens prosjektmodell), the front-end phase covers the idea phase, the concept evaluation phase, and the pre-project phase.

In the introduction (Chapter 1) of the report, we argue that while there is good reason to discuss how and how thoroughly a front-end phase should be conducted, it is difficult to imagine that the public sector will be able (or should) invest large

¹ EDOS: Effektiv Digitalisering av Offentlig Sektor (Efficient Digitalization of the Public Sector). A research center at Simula Metropolitan Center for Digital Engineering financed by the Ministry of Digitalization.

amounts in IT development without analysis of needs, solution alternatives, and profitability, requiring realistic estimates of costs and benefits. In other words, many public investments will require a front-end phase, regardless of the degree of agility in the implementation of IT development.

In Chapter 2 of the report, we first describe what the front-end phase looks like for the largest public IT projects, i.e., those that follow the State Project Model and for projects that follow the governmental Project Guide (Projektveiviseren). Then we provide a description of different approaches for front-end, financing, and implementing product-organized IT development with permanent teams. Here we point out that it does not have to be an either-or choice, or opposition, between project and product organization of IT development. We offer some considerations on how principles of agile IT development can guide the front-end phase, and report from a survey on the front-end phase in the public sector, compared to the private sector. This survey was first conducted in 2018 (not published) and then repeated in 2023 and gives much of the motivation for the importance of our study of the front-end phase in the public sector. Results from the survey suggest, among other things, that:

- The average length of the front-end phase for IT development in the public sector, for projects between 20 and 100 mNOK, increased from 1.5 years in 2018 to 2.3 years in 2023. For both years, the public sector spent about twice the time on the front-end phase as in the private sector.
- The front-end phase in the public sector was perceived by most respondents to be too extensive to ensure good implementation of IT development. This has not changed from 2018 to 2023.
- The budgeting process in the public sector was not perceived to be well adapted to agile IT development. This had also not changed from 2018 to 2023.

In Chapter 3, we report from the first of the two literature reviews included in the report. This review aims to identify and summarize results from research on how cost and benefit estimation is done in the front-end phase of agile IT development, how good the estimates are, and connections between what is done in the front-end phase and how successful the agile IT development is. We identified 42 relevant articles suggesting that:

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- Cost and benefit estimation is mostly done in the same way for agile as for non-agile IT development, with a few exceptions where estimation of agile IT development is significantly less detailed.
 - Cost estimation is almost always based on expert estimation.
 - The time it takes to prepare the basis for cost and benefit estimation in the front-end phase is on average about the same for agile as for non-agile IT development.
 - The optimal scope of the front-end phase for agile IT development seems to be lower when the complexity of IT development is low and the experience level with similar IT development is high than when this is not the case.
 - More effort on high-level estimation and planning in the front-end phase of agile projects typically has a good effect on project implementation, while more effort on detailed estimation and planning typically has a negative effect.
 - Agile IT projects vary greatly in estimation accuracy for estimates made in a front-end phase, but typically have between 10% and 40% underestimation of implementation time and cost.
 - Measurements of estimation accuracy for benefit estimates indicate that on average about 90% of the benefit estimated in the front-end phase is realized, and that 90% of agile IT projects deliver benefits at least at what is perceived to be an acceptable level.
 - Connections between what is done in a front-end phase and the degree of cost control in the implementation of agile IT development are largely the same as for non-agile IT development. Planned flexibility in deliveries and experimentation in the front-end phase, however, seem to be more effective for agile IT development than for non-agile IT development.
 - Connections between what is done in a front-end phase and the degree of realization of benefit effects in the implementation of agile IT development are particularly related to the ability to formulate benefit effects so that they can be evaluated and managed. The choice of appropriate budgeting strategy and contract type, where for example per

hour type contracts deliver more realized benefit, also seems to be important.

- On average, agile IT development is more successful in most areas than non-agile IT development.

In Chapter 4, we report from the second literature review. Here we identify and summarize research, from many different domains, that contains empirical results related to alternative activities in the front-end phase of product and service development. We identified 12 relevant articles. These made, among other observations:

- A more agile front-end phase, where planning is done iteratively in the implementation phase instead of being detailed already in a front-end phase, seems to give good results on the quality of the plans, implementation, and deliveries.
- Traditional planning practices emphasize the establishment of accurate requirements and detailed plans. This often comes at the expense of promoting collaboration and flexibility to changes.
- There are many alternative budgeting processes and contracts in use. Experiences with these are mostly positive. Several of these budgeting and contract types make the front-end phase for agile IT development likely to be simpler and faster.
- Several of the proposed non-traditional contract types and financing methods are likely to work better for agile than for traditional projects. The core elements are flexibility, collaboration, and risk-sharing.
- Experimentation ("agile trials") as part of the front-end phase is reported to provide better quality of deliveries.

In Chapter 5, we report on our studies of Norwegian IT projects in the public sector. We analyzed 17 projects that followed the State Project Model, 3 projects from the defense sector, and 10 projects financed through the Co-financing Scheme (Medfinansieringsordningen). In addition, we analyzed the front-end phase of three organizations that all had a product organization of IT development. A selection of the results is given below.

Results related to IT projects

- About half of the examined projects had major deviations either in costs, time use, or delivered benefits.
- Few of the projects using the State Project Model fit into the sequential model for the front-end phase, with concept evaluation, project planning, and project implementation carried out in sequence.
- The length of the front-end phase is determined to a relatively small extent by the size or length of the project.
- Cost estimation of agile IT projects seems to be based on the same estimation processes as for non-agile, but increased agility seems to be able to lead to estimation at a higher level of abstraction.
- There is very rarely a reality check of the cost estimates by external quality assurance (QA1 and QA2). Instead, the quality of the estimation process is assessed.
- Time estimates typically receive much less attention and have a lower degree of structured processes than cost and benefit estimates. This applies to both external quality assurance and the projects.
- Benefits estimation consists of many different estimation processes, determined by the type of benefits to be estimated. It is a possible challenge that the calculation of cost savings based on saved minutes is not always compatible with the organization's ability to actual cost savings.
- We find a weak positive effect of an increased proportion of internal resources on better project outcomes. No projects had more than 60% internal developers, so this does not say anything about an increased proportion of internal developers beyond 60%.
- The effect of increased project size is virtually zero for cost control and benefit realization, and only weakly positive (for time management and total success).

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- A longer front-end phase is associated with a greater degree of project problems, without us being able to say that a longer front-end phase causes these problems.
 - The three main causes of project problems that could be traced back to the front-end phase were perceived to be i) too little work to understand complexity and consequences, ii) lack of anchoring, involvement, and dialogue with involved actors, and iii) too little time for competence development/front-end without resources with sufficient competence.
 - The most important front-end phase factors for success were perceived to be: i) clear priorities and objectives, ii) stability and quality of resources used in the front-end phase, iii) accountable actors, and good anchoring, iv) good quality of planning for implementation, v) good quality of decision-making basis, vi) not too detailed estimates, vii) a high degree of flexibility in the plan for implementation and in the deliveries, viii) decision-making authority, and ix) a good process for finding the right suppliers.
 - The most important areas for improvement in the front-end phase were perceived to be: i) less detail orientation in the work with estimates and plans in the front-end phase, ii) more focus on the development of good benefit management plans, iii) more use of experimentation in the front-end phase, iv) better interaction with external quality assurance, v) starting with smaller deliveries, before the rest is investigated and planned, vi) more time for anchoring and analysis in the front-end phase, vii) ensuring that resources from the front-end phase are included in the implementation phase, viii) more flexibility in how the front-end phase is conducted. The most important obstacles to achieving the improvements were perceived to be related to one's own organizational culture and processes, as well as the state's instructions and requirements for investigation and planning.

Results related to external quality assurance (QA1 and QA2) in the State Project Model

- The average duration of external quality assurance for the projects that followed the State Project Model was 2.7 months for QA1 (based on only a few quality assurances) and 3.6 months for QA2.

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- There appears to have been a clear decrease in the time spent on QA2 from before 2020, with an average of 4.8 months, to 2020 and later, with an average of 2.8 months.
 - The time spent on QA1 and QA2 seems to be well motivated, both from the need of the external quality assurer to familiarize themselves with and mature regarding issues, and from the scope of activities carried out.
 - The projects are largely satisfied with the benefits of external quality assurance.
 - Several quality assurers pointed out that there should be, and probably was, an opening for more agility in the front-end phase. This particularly applies to the level of detail in the solution, estimates, and plans in the front-end phase. Here there could be a conflict between what has traditionally been required of detailing in the basis documents for external quality assurance, and what particularly the most agile of the projects wanted to spend time on in a front-end phase. In practice, the projects were largely able to carry out the front-end phase with the level of detail they deemed most appropriate for their purpose.
 - To streamline, and possibly shorten, the implementation of external quality assurance, the following measures were proposed: i) Quality assurers are involved earlier in the front-end phase, ii) Early expectation clarification between quality assurer and project, iii) Better training of project participants in key processes and analyses before the project, iv) Use of the same company (and not too many different ones) for both QA1 and QA2.

Results related to the analysis of IT development organized as product development with permanent teams

- Front-end according to the State Project Model in organizations with product organization is feasible, but is experienced as cumbersome and not optimal.
- There is a strong desire to explore the possibilities for alternative ways of financing and starting up this way of organizing IT development.

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- Improvement suggestions include both completely abolishing project financing in favor of fixed financing, and having financing better adapted to agile development, for example through incremental financing and continuous quality assurance.

In Chapter 6, we provide recommendations based on the results from the entire report. The recommendations include, among others:

- A shorter and simpler front-end phase of agile IT development should be a goal for many projects. This is especially true for projects where the complexity and risk in execution are relatively low, and where the implementation part is intended to be carried out with a high degree of agility.
- The thoroughness and duration of the front-end phase should be determined by the complexity and risk of the IT development, and very complex projects will still be able to require a thorough and comprehensive front-end phase.
- One alternative, or supplement, to increased thoroughness in the front-end phase for very complex projects is increased use of agile elements. This can, for example, be based on an increased degree of experimentation and testing (hypothesis testing, "fail fast", "agile trials").
- Use of the same people in the front-end and implementation phase.
- Increased openness to (experimentation with) financing models better adapted to agile IT development.
- Experiment more with and gather experiences with the use of "Design to cost" (DTC) and "Design to time" (DTI).
- More emphasis on thoroughness of the core components in the front-end phase, i.e., the components that are experienced to be most important for success in implementation.
- What is estimated and at what level of abstraction it is estimated for agile IT development should depend on the degree of experience with similar IT development, the degree of uncertainty in implementation, and the real need for detailing.

- More focus on good processes for, and quality assurance of, the estimation of calendar time.
- Benefit estimation should be better linked to the management of agile IT development. This includes, among other things, better formulations of benefit effects, so that they can be used for ongoing benefit management and evaluated afterwards, as well as a good connection between objectives at different levels, benefit effects, and deliveries.
- Better inform about and improve the use of the flexibility and opportunity space of the State Project Model, and clarify that project and product organization can work together and are not necessarily either-or.
- The current duration of external quality assurance in the State Project Model, both KS1 and KS2, seems to be well justified, but can probably be streamlined and shortened if quality assurers are involved earlier.
- Requirements for documentation of the estimation process, both to provide an incentive for the use of good estimation processes and to enable external quality assurance of the estimates.
- Utilize the opportunities for benefit management even better in the Co-financing Scheme.
- Spread knowledge about and experiences with how benefit management is done in the front-end phase for IT projects financed by the Co-financing Scheme to other parts of the public sector, including projects that follow the State Project Model.
- Consider the use of "beyond budgeting" principles, ongoing allocation of funding instead of only once a year, for the Co-financing Scheme.

In Chapter 7, we provide some general conclusions on the possibility to unite to needs from the financing side of IT development and the desires from agile IT development environments for more flexible financing methods and more agility in development.

We also introduce a *Cynefin*-based framework that, in conjunction with the findings presented in the report, can be utilized to guide the design of an appropriate front-end phase for agile IT development. For IT development characterized as *simple*, a

very short and high-level front-end phase should be crafted, albeit incorporating most of the traditional front-end phase activities. IT development classified as *complicated* may proceed with a traditional front-end phase, though perhaps executed faster and at a higher level than typically practiced today. IT development characterized as *complex* will derive the most benefit from and, to some extent, require an alternative front-end phase where current guidelines and project models seem to be least suitable. This front-end phase should instead be based on experimentation, iteration, and learning, allowing solutions and plans to be developed iteratively. It is likely that alternative funding methods will also be necessary in this context.

We also report some considerations on that we must expect major changes in the times ahead, for example, based on increased use of development tools based on artificial intelligence. We, therefore, need a continuous focus on experimenting with different software development processes and organization principles, gathering and summarizing experiences, as well as sharing and disseminating the experiences. All this in good agile spirit.

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