Designing a Tool for Measuring IT Process Maturity in an Agile Development Context

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Abstract

This paper presents the design of a tool for recurring quantitative self-assessment of IT Service Management (ITSM) process maturity in an agile environment. Continual improvement of ITSM processes can be measured by performing a process maturity assessment, comparing the organization's process performance against a best-practice reference set of processes. In this paper we report a project that has developed a quantitative measuring survey-based tool. The specific context for the research is a financial institution that has adopted agile development. This change brought on an increased need to monitor ITSM process performance, and a Design Science Research (DSR) project was launched to create an ITSM maturity assessment tool. The results show that a company-wide ITSM process maturity assessment can be established as a survey-based self-assessment, and that the aggregate scores from this self-assessment present a good indicator of the organization's process performance, especially when complemented by a reference score. A key learning from the study is that the iterative DSR methodology made it possible to create a system that in good way measure ITSM process maturity.

Keywords: ITSM, IT Service Management, IT Maturity, Process Maturity, Quantitative Self-assessment.

1. Introduction

IT services are under constant pressure to become better, faster and cheaper [1] and IT Service Management (ITSM) processes are constantly evolving. The continual improvement of IT service management processes can be measured by performing a process maturity assessment, comparing the organization's process performance against a best-practice reference set of processes [2, 3]. There are several assessment frameworks available, but most existing assessments are very resource demanding, which makes them expensive to apply – especially when repeated regularly. As an alternative organizations has started to seek after lighter assessments methods to perform self-assessments [4].

However, at the same time as business demand drives improvement of ITSM processes, many IT Service Management organizations are adopting agile software development methods [5, 6]. They do so in order to improve time-to-market [7] as well as improve customer satisfaction [8]. Despite the fact that the agile way of working improves the speed of development and alignment with customer needs, the more informal way of working may create gaps in process compliance as well as in process maturity [9]. This is especially likely during the transition to the new way of working, while process participants are still adjusting to new roles and responsibilities. Organizational change may impact control and feedback cycles of IT processes due to low process awareness, incomplete role adoption and other transitional effects. In addition, differences between waterfall and agile may exacerbate negative effects, if not

mitigated properly [10].

Therefore, when IT departments are undergoing organizational changes to agile way of working, it would be prudent to evaluate process maturity throughout the change, to ensure that lapses in process compliance and maturity can be handled swiftly [10]. In this paper we describe development of a survey-based tool (in the rest of the paper we just write tool) for self-assessment of IT process maturity at a large financial institution, aiming at indicating process maturity level at the financial institution.

Process maturity level is an indication of how well a process achieves its objectives, and whether the process is capable of continuous improvement [11]. The assessment of process maturity is commonly used as the starting point for ITIL implementations [12] to pinpoint improvements that would be the most beneficial to perform. However, assessments are equally valuable for understanding as-is state for planning continuous improvements and evaluating overall performance of IT organizations. So, whenever an organization is undertaking a process improvement initiative, or going through organizational change, there is a need for assessing process maturity [13]. Furthermore, to gauge the progress of improvements, or the impact organizational changes cause to processes over time, the measurement should be applied at regular intervals and cover the key roles and organizational departments. The most common approaches to measure maturity are qualitative assessments, conducted through interviews or extensive questionnaires, which are complex, time consuming, and expensive to apply [14].

The research question addressed in this paper is: How to design a tool for measuring IT process maturity in an recurring and effective way? This question is discussed from a DSR project that designed and tested a quantitative self-assessment survey-based tool for measuring IT maturity.

The rest of the paper is organized in the following way: section 2 presents the context of the project. This is followed by an overview of the development approach (section 3) and research methodology (DSR) in section 4. Section 5 presents a brief overview of three iterations of development and testing of the maturity assessment tool. Section 6 discusses the results and the development approach, and the final section presents some concluding thoughts.

2. The Context of the Project

The context of this project is a large multinational financial institution with around 16,000 employees. A major part of the company's systems is created in-house due to the nature of the business, and it exist a lot of legacy systems. The internal IT development process has been heavily influenced by hardware-oriented development approaches and has historically been built around a waterfall approach. The development process has been well-integrated with IT governance, resource management, and financial process. However, from a user perspective the waterfall-inspired approach has the downside of long lead times and slow feedback cycles.

To mitigate downsides (long lead time and slow feedback) of the waterfall approach, the company introduced an agile approach in some teams over a period of 3 years, and since 2018, the agile approach is fully implemented throughout all business areas.

The department-based way of working with clear distinction between IT development and maintenance roles was replaced with cross-functional teams handling both development and operations while working with a common backlog.

The change to agile development process affected the ITSM processes by changing roles and responsibilities, organization structure and the speed of introducing new services into the production environment. The changed dynamics of the way services are developed and operated impact the IT process maturity in various ways, and therefore it was important to evaluate process maturity changes across different affected teams throughout and after this organizational change. This resulted in the situation that there was a need for having a recurring and effective way of measuring IT process maturity.

Several risks arising from the organizational transition from centralized, waterfall-based way of working to decentralized, agile way of working have been identified, which can impact IT process maturity and compliance. Among transitional effects are the

incomplete role adoption, low process awareness and team motivation issues during formation of new cross-functional teams.

In the financial institution it is a fact that the decentralization lead to uneven performance between different business units due to different adoption speed of new way of working. Additionally, the decentralization resulted in inefficiencies and duplication of control and management activities.

Additional issues may arise from conflicting priorities between development and maintenance tasks, as work is handled by the same cross-functional team and prioritized in the same backlog. All this made it necessary to get a better understanding of IT maturity in the financial institution and this reason was the starting point of the project that aimed at developing a tool for measuring IT maturity. However, in this paper the specific focus is on development of a self-assessment tool.

3. Development of the Self-assessment Tool

The choice of Design Science Research (DSR) was based on the premise that DSR methodology can support an adaptive and responsive design process which aligns with the agile IT management practices introduced in the organization in question. In DSR creation of an artefact is central. In this case it is a survey-based tool that contains questions as well as storage of results and possibilities to evaluate and present the results in different ways.

To be able to gauge the impact of organizational changes to the process maturity level, maturity assessment needs to be performed regularly, so it can identify trends and provide feedback while the new way of working becomes the norm. A full CMMI assessment is unsuitable for establishing trends in a short timeframe due to the cost, disruption and long feedback cycle. Therefore, the IT Process Maturity Assessment project aimed to implement a survey-based self-assessment, which can be applied repeatedly across a broad spectrum of roles and business areas within an IT organization.

The framework selected as basis for the process maturity assessment initiative was CMMI-SVC. CMMI® (Capability Maturity Model® Integration) models are collections of best practices that help organizations to improve their processes. The CMMI framework describes performance of individual process areas in terms of capability, and the overall performance of the IT processes in terms of maturity.

The capability levels indicate the extent of implementation and performance of the processes corresponding to a given process area. The four capability levels are numbered 0 through 3. Capability levels serve as an indicator for improving individual processes.

Maturity levels apply to an organization's process improvement achievement across multiple process areas. These levels are a means of improving processes corresponding to a given set of process areas (i.e., maturity level). The five maturity levels are numbered 1 through 5. Table 1 presents the alignment of the four capability levels and the five maturity levels.

Table 1 Capability and Maturity levels as per CMMI [15]

Level	*Continuous Representation Capability Levels*	*Staged Representation Maturity Levels*
Level 0	Incomplete	
Level 1	Performed	Initial
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4		Quantitatively Managed
Level 5		Optimizing

CMMI-SVC draws on concepts and practices from CMMI and other service focused standards and models, including ITIL, ISO/IEC 20000: Information Technology—

Service Management, Control Objectives for Information and related Technology (COBIT) and Information Technology Services Capability Maturity Model (ITSCMM).

The research used the three-cycle view of the DSR methodology [16, 17] and in Figure 1 we describe adoption of the framework to the specific context of the project.

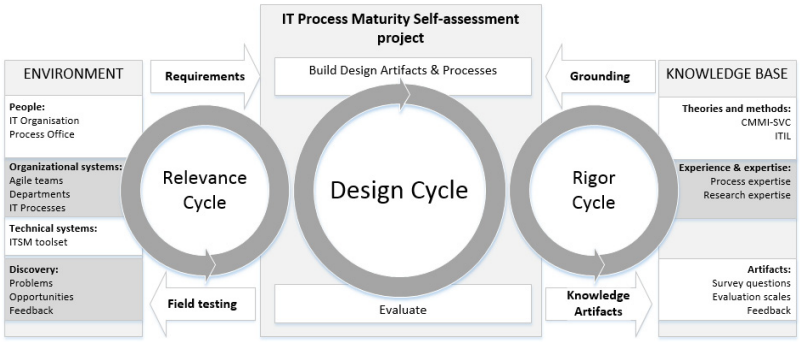

Fig. 1. The DSR framework adopted in the project

4. The Projects Research Method

Research method wise there were mainly two researcher working within the project. One of these, which could be called practice researcher, worked at the financial institution and had time in his employment to work with the development of the tool. This setting could be related and described to what Goldkuhl [18] define as practice research. The practice researcher actually conducted research as a master student before the project started, and his master thesis was one of the starting points for the project. When presenting the master thesis at the financial institution he got positive feedback on continuing with developing a tool for measuring IT maturity in the financial institution. The other researcher worked full time at a university. He was approached by the practice researcher and acted as supervisor on the master thesis, which were connected to another university compared to the university the university researcher worked at. All this means that the project started from the perspective that it had a good overview of literature on IT maturity, and from that perspective it was decided as conducting the project as a design science research project and not a action research. This also meant that it had a pragmatic stance as presented by Goldkuhl and Lind [19] when they present a multi-grounded design process. The combination of the practice researcher and the university researcher made it possible to execute the project as a design science research in which the two researcher had a good combination of insights. The project as reported in this paper was conducted in three iterations. Before and in between each iteration workshops was conducted. In this workshops the tool was presented and it was discussed by different experts and engaged stakeholders both from the IT department and from different business departments. All in all this made that the two cycles, rigor cycle and relevance cycle, was considered to a high extent in the project. The relevance cycle provided input from the contextual environment of the research project to the design science activities. The rigor cycle was used to bridge the design science activities with the knowledge base of scientific foundations, domain experience, and expertise that provides guidance to the research project. The central design cycle iterated between the core activities of building and evaluating the design artefacts and processes of the research [17]. This is presented in the next section, in which we go through the first three design iterations of the tool.

5. Results of the First Three Iterations

In this paper we describe development of the tool for measuring IT process maturity at the Financial institution through its first three iterations. The project was timed to coincide with the agile transformation of the IT organization. The tool selection for establishing the IT process assessment program was based on the main considerations that the surveys would need to be digitally accessible within the Financial institution IT

environment, and that the artefacts and data should be stored using the existing collaboration tools. The chosen survey platform was Netigate digital survey tool (Netigate AB, Sweden), since that tool was already in use within the Financial institution. The results were processed in MS Access and MS Excel.

The assessment focused on the IT service providers feedback and the key characteristics of their perception of process outcomes. The targeted process roles as users of the tool in the Financial institution IT service management organization were service portfolio managers, service owners, service managers and team managers.

5.1. Iteration 1 – Pilot Survey

The pilot survey was initially planned to cover only three process areas, and initially selected process areas were Service Design, Incident Resolution and Prevention, and Service Continuity. The idea of this restriction was to verify the survey method and test the assumptions in a reasonably short timeframe with manageable effort. However, it was decided to extend the limited scope, since it was assumed that a too limited scope would not have provided enough insight to prove value of the model. The scope was extended to cover CMMI process areas from several maturity levels to allow the results to be mapped to a process capability score and a relative process maturity score. The project team therefore selected several well-established IT-processes and mapped these to CMMI process areas.

This means that the pilot survey investigated 11 processes as shown in table 2, which presents the survey scope as applied to selected IT-processes, and the respective counts of questions asked in the tool. The number of questions for each process was decide by the researcher after discussion with process experts at the Financial institution. The specific number was seen as enough for stating the maturity level on each process. Regarding the specific number of questions, this is a trade-off between having a questionnaire that takes too long time to answer and having trustable answers. This was managed by having knowledge and input from process experts. From the evaluation of the results it can be stated that the survey had enough questions for fulfilling the goal, especially since the goal was not to draw any statistical inference.

Table 2. Financial institution IT processes in scope of the test of the assessment tool.

Financial institution IT process	**Number of questions**
Availability Management	2
Capacity Management	2
Change Management	4
Incident Management	5
IT Service Continuity Management	3
Problem Management	4
Service Asset and Configuration Management	2
Service Level Management	5
Service Portfolio and Catalog Management	2
Continual Service Improvement	4
Service Transition	1

When mapped to CMMI process areas, the survey scope refers to maturity levels one to four (see Table 1, level 1 initial until level 4 quantitatively manageable). This limitation, excluding level five, was deliberate, as the likely maturity score at the time of the initiation of the project was seen as be around 2, and there would be less benefit in designing questions that cover level 5 features.

The CMMI process area specific goals and respective specific practices form the basis for designing the questionnaire as well as the questions, which addressed key

outcomes of the processes, as described by CMMI-SVC. The survey was designed with closed questions, with only a fixed range of answer options on an ordinal scale.

In the first iteration, response options were a mix of binary "yes-or-no" choices and some ranges of Likert-type items. The logical order of the questions was defined using the ITIL Service Lifecycle steps [20] of Service Strategy, Service Design, Service Transition, Service Operation and Continual Service Improvement. The questionnaire was developed in close cooperation with process experts at Financial institution to ensure that the use of terminology and wording would be familiar to survey participants.

The pilot survey was launched at a time when organizational change had just taken effect and the recruitment process had not finished, so the new Service Provider roles were not fully established in the organization. The respondents for the pilot survey were selected from the people who were in a Service Provider role in previous organization and had retained the equivalent role in the new organizational setup. This decision regarding population selection would ensure that respondents were familiar with the process framework and would be knowledgeable for providing feedback to the survey content and format.

The final agreed population for the survey contained 229 names. This list was comprised of all people marked as a Service Owner for active services in the IT service portfolio. The selected population formed an estimated 20% of the total direct participants of IT service management processes at the time. The survey was sent out and was open for 11 days. Out of the 246 invites, 72 people responded, and 53 people completed the survey.

In an ordinal scale, responses can be rated or ranked, but the distance between responses is not measurable. Thus, the differences between ''most,'' ''some,'' and ''few" on a frequency response Likert scale used in the survey are not necessarily equal.

Descriptive statistics, such as means and standard deviations, have unclear meanings when applied to Likert scale responses. For example, what would the average of ''most" and ''some'' really mean? Furthermore, if responses are clustered at the high and low extremes, the mean may appear to be the neutral or middle response, but this may not fairly characterize the data.

In this case, means are of limited value for describing the results, as the data does not follow a classic normal distribution, so instead a frequency distribution of responses was used. The results were summarized to divide process areas into two: those receiving on average higher scores, and those with a majority of low scores. "Don't know" was counted towards low score. The following table presents the processes with indicative good and bad performance.

Table 2 Pilot survey results

	Low score	**High score**
Service Design	Service commitments Service reporting Recovery plan testing	Service definitions
Service Transition	Configuration management Service handover	Change management
Service Operation	Outage registration	Incident management Problem management
Continual Service Improvement	Using operational metrics Using KPI for improvements	Root cause analysis

The survey participants were also asked to provide feedback to the survey content and process. 16 respondents left a comment in the survey, and a few more participants provided direct feedback to the project team either by email or verbally. The main feedback was related to the issue of comprehension. This feedback was then used as input for improvements of the tool before testing it in iteration 2.

The adjusted response rate after excluding invalid responses was 32% and the aggregated results of the survey can be considered statistically significant. As the total

population of Service Owners at the time of the pilot survey was 229, the total of 72 responses indicates a 9,5% margin of error at a 95% confidence level. The results should be considered nonparametric, as the sample was chosen based on their specific role in IT service management.

5.2. Iteration 2 - Q4 2018 Survey

The second iteration of the self-assessment tool for IT process maturity was developed in Q4 of 2018 and targeted an increased range of service management roles in the IT organization. The population of interest for the second iteration covered the roles of Service Owner, Team manager and Service manager for all active services in the IT Service Portfolio. These roles are the key actors in the ITSM processes, so responses from this population would reflect the state of the whole IT organization.

The assessment added a more detailed perspective of process capability level. The specific goals and the respective specific practices for the CMMI Process Areas forming the basis for designing the questionnaire are stated in a hierarchical order. This means the questions could be mapped to respective process capability level. Each question was mapped to the specific practices it referred to, so the response could be translated to a capability score, as well as a maturity level.

The final agreed distribution list for the survey contained 504 names, and this population formed an estimated 40% of the total IT service management process participants at the time of the survey. The invitations to participate in the Q4 process maturity survey were sent out on and the survey was open for 10 days. Out of 504 invitees, 195 people responded, and 167 people completed the survey.

To report outcomes in terms of process maturity and capability, the frequency table was matched to the question match table. This allowed for the results to be compared to the maximum possible score for each process area.

The results in iteration 2 were presented in a more detailed way, expressing both the maximum possible process capability score as covered by the assessment, and the resulting capability score. The processes were presented in the overall process maturity steps by matching CMMI specific goals and specific practices to the organization's IT processes. The resulting graph is presented in Figure 2.

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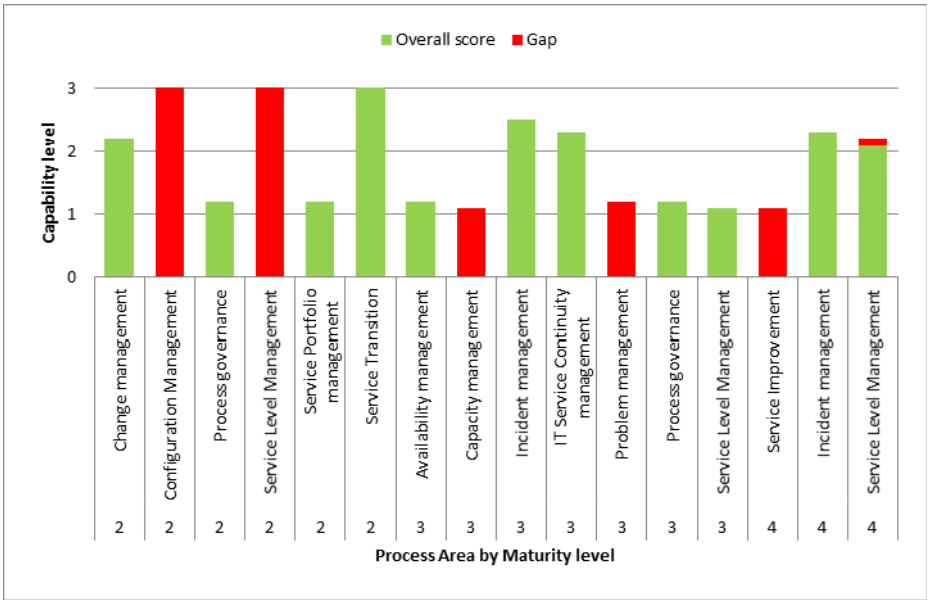

Fig. 2. Iteration 2 results by process area.

In this graph, the Financial institution IT process areas are mapped to CMMI maturity levels on the horizontal axis, and the specific process capability results (green) are presented against a possible maximum score (red) on the vertical axis. The red areas highlight the process capability gaps, where the specific goals of the process are not

achieved by the organization. As the respondent's results are subjective and depend on the process participant's knowledge, experience and attitude towards IT processes, the negative results may indicate both a problem with process capability and a lack of knowledge among process participants.

To distinguish between areas where the gaps are related to process participant's awareness, as opposed to process capability, the score achieved by the process participants was compared to a reference score compiled by process experts (Figure 3). This score is based on expert opinion and operational statistics from the organization.

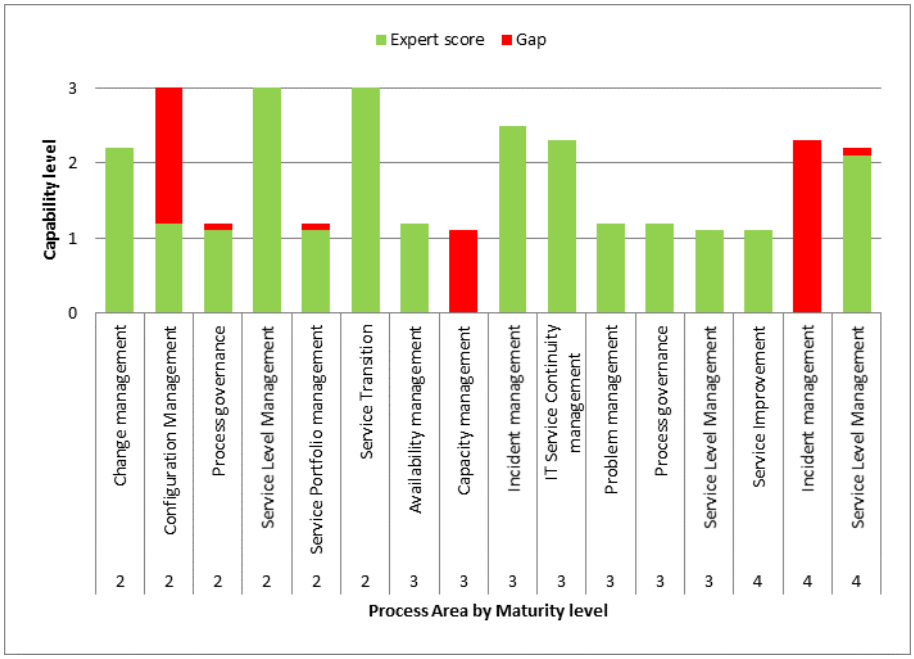

Fig. 3. Iteration 2 expert score by process area.

The comparison of results in Figure 2 and Figure 3 indicates, that the low results in Service Level management, Problem management and Service Improvement area may be due to a low awareness, or misunderstood questions. However, the relatively low scores for Configuration management and Capacity management are likely due to low process capability.

The larger sample in iteration 2 allowed for responses to be summarized by business area and role, so gaps could be identified, and specific mitigation actions suggested for IT management in general, and for business area management teams specifically.

The adjusted response rate for the Q4 survey was 39%. The aggregated results of the survey can be considered statistically significant. As the total population of Service Owners at the time of the pilot survey was 504, the total of 195 responses indicates a 5,5% margin of error at a 95% confidence level. The results can be considered parametric, with non-normal distribution for role.

5.3. Iteration 3 – Q2 2019 Survey

The third iteration of the self-assessment tool for IT process maturity was developed in Q2 of 2019. In the third iteration, target population remained the same as in the second iteration, but the scope of process outcomes was increased. The capability ranges covered by the assessment were harmonized, so process scores would be comparable, allowing better visualization of process capability results using a spider-web graph.

The distribution list for the survey contained 558 names, and this population formed an estimated 40% of the total IT service management process participants at the time of the survey. The invitations to participate in the Q4 process maturity survey were sent out and the survey was open for 16 days. Out of 558 invitees, 199 people responded, and 153 people completed the survey.

The results in iteration 3 were presented as a spiderweb graph, with processes divided

into the process maturity steps as prescribed by CMMI-SVC. This view expresses both the maximum possible process capability score as covered by the assessment, and the resulting capability score, and highlights process capability gaps for each ITSM process maturity level. The resulting graph is presented in Figure 3.

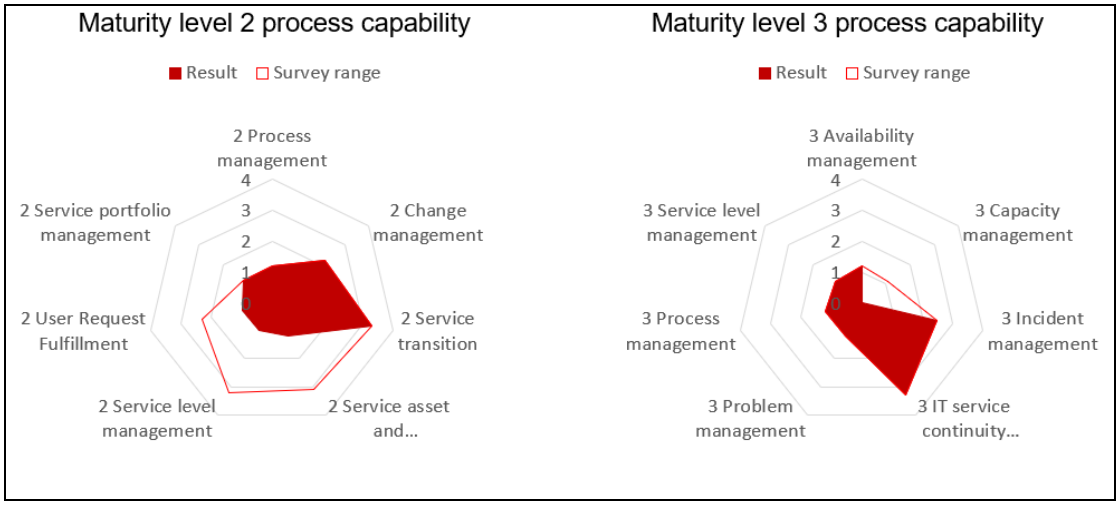

Fig. 4. Iteration 3 results by process area.

The results were also cascaded by role and organization structure, which meant that the gaps could be identified, and specific mitigation actions suggested for specific roles and for business area management teams.

The main improvement idea from project stakeholders for the third iteration was related to the process capability ranges covered by the survey. The idea for next iterations is to harmonize the ranges, so that all individual process results could be matched to a capability score of 0-3. This will improve the ability to pinpoint improvement activities and enable the calculation of a CMMI-SVC maturity score above level 3. This presents a challenge in terms of survey scope, as the number of survey questions and the average time to complete the assessment would increase.

6. Discussion

The research method used in this design science research project, Hevner's 3 cycle model [17], bridges contextual environment with design science activities, and design science activities with the knowledge base. By iterating through these cycles, the developed artefact (the survey-based tool) is expected to contribute with new knowledge to the scientific evidence, and to the real-world applications [21]. In the current research, contextual environment is the organization with its people, processes and tools. By bringing the developed artefact into its environment, the research gained feedback about its applicability and usefulness to the participants and stakeholders. This iterative nature of the method supports an adaptive and responsive design process, which enables the improvement of the requirements, the knowledge base and the developed artefacts throughout the development process, similar to the central idea of agile development, in which design practices react and adjust to changing user requirements [22]. This study reflects the view of Conboy, Gleasure and Cullina [23], which points out that the problem space in DSR projects could be seen as emerging and evolving in tandem with the solution space, and encourages an agile approach to problem identification.

In the first iteration, management stakeholders receiving the report of the assessment results provided feedback on the lack of granularity of the results in terms of business areas and roles. This was improved in the second iteration by extending the survey scope to more roles across all business areas and presenting the results accordingly. While the report on the assessment results in the first iteration was simple and provided a brief overview of process areas which needed improvements, in the second iteration results were presented in the dimensions of capability and maturity. The added perspective was

appreciated by the stakeholders, but the presentation was considered too complex. In the third iteration, the capability ranges covered by the assessment were harmonized, so the process scores are comparable. This will allow for better visualization of the process capability results using a spider-web graph.

Previous research [24] has indicated, that self-assessments tend to have an upward bias on the capability scores when compared to an in-depth analysis of IT process performance. Johansson, Eckerstein and Malmros [24] associated this bias with the participants' low specialist knowledge in process areas in question and surmised that the results would be more reflective of the true state if all survey participants were ITIL-educated.

In the research at the Financial institution existence of the bias problem was tested by comparing survey results to an expert score established by process managers using operational data and in-depth knowledge of the individual processes. This bias was not observed, and the difference with previous research may be attributable to two factors: the wording of the questions and the interpretation of the responses.

First, in this survey tool wording of questions was tailored to fit the organization by using terminology which is used in the organization's ITSM tool, work instructions and training materials. The wording and presentation of questions was also reviewed and improved in several iterations to make it as intuitive and clear as possible.

The maturity assessment is currently focused on level 2 and 3 process areas, as the target organization is operating at this level. However, as the organization is also on an agile journey, there may arise potential conflicts between the goals of CMMI-SVC maturity and agile methods. The reason for the mismatch is the different objectives: while agile is aimed at lowering cost, improving productivity and customer focus [25], CMMI is more broadly aimed at governance on the organizational level [26].

A literature review performed by Henriques and Tanner [27] also indicates that agile and CMMI are not a natural fit at higher maturity levels, and further points to a lack of research into the use of agile methods to achieving CMMI maturity levels beyond level three.

Boehm and Turner [28] have pointed out, that while in principle agile methods are in line with level 5 maturity concept of constant adaptation of operations to improve performance, most agile methods do not support the degree of documentation and infrastructure required for achieving lower-level maturity. This is another area where the DSR approach may benefit the project, as the knowledge base and the maturity evaluation criteria will need to evolve along with the assessment tool itself.

7. Concluding Remarks

The creation of an IT process maturity self-assessment tool has a pragmatic focus due to its emphasis on relevance – the outcome needs to be useful for the organization, i.e. the application environment. In this way, a DSR approach for developing assessment is quite appropriate, as it focuses on applicability of the developed artefact. However, practical utility alone is not enough. It is the synergy between relevance and rigor and the contributions along both relevance cycle and rigor cycle that define good design science research [16], and this is achieved in this case by using Hevner's three cycle model.

This research is centered on designing a self-assessment survey-based tool for measuring IT process maturity where the trigger for organizational change was an agile transformation of IT development and operations in the organization. As the transformation continues, the maturity assessment activity should also continue, as process performance can be considered an emergent property, which is a function of organization culture, tools and technology, and the process framework. Thus, it is constantly changing in response to changes in the organization, the tools in use and the processes themselves. Therefore, any initiative to measure process maturity should be continuous, and constantly evolving. The same need for process maturity assessment may arise from any other major reorganization of the business, e.g. mergers and acquisitions, major changes to business model etc. Measure process maturity, as in this case, can provide opportunity to identify trends and to assess impact of improvement activities.

The simplified nature of the tool means that it can be applied regularly, and the iterative nature of the way the tool is managed means it can be adaptive and responsive to enable its use for monitoring process maturity trends in a changing organization.

We believe that despite the differences of approach, CMMI is an appropriate framework for improving ITSM processes in organizations utilizing the agile way of working. Future development of the tool will hopefully contribute to the understanding of what level 4 and 5 maturity means in an agile environment.

In the future, one avenue of research to explore could be to compare the process maturity assessment results with Employee Net Promoter Score (eNPS) results and other internal performance metrics to see whether there is any correlation, e.g. between process performance and employee satisfaction. This would provide an interesting perspective to both process improvements and HR initiatives.

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