Measuring Team Innovativeness: A Multiple Case Study of Agile and Lean Software Developing Companies

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Abstract. **[Context/Background]** Innovation is seen as the basis of competitive economy and measuring the innovation process is important for organizations. In the literature, focus has been on innovation and innovation capabilities on an organizational level, while few studies has been placed on innovation at team level. Furthermore, organizations tend to focus on the measurement of innovation to input and outputs of the innovation process and ignoring the process in-between. **[Goal]** This paper explores how a team's innovation capability is measured, and can be measured in practice in agile and lean software developing companies. **[Method]** It is based on data collected through semi-structured interviews with 28 practitioners from 11 software developing companies. **[Results]** The contribution of this study is twofold: First, it characterizes which metrics are used in industry to measure a team's innovation capability. Second, it identifies which metrics that could be used in practice to measure a team's innovation capability. **[Conclusions]** Measuring the performance of the innovation process is not seen as important during product planning and development.

Keywords: Innovation · Measurement · Agile · Case study · Empirical

1 Introduction

Innovation is widely seen as the basis of a competitive economy [21] and has resulted in a multidisciplinary body of knowledge. This multidisciplinary body of knowledge shows that an organizations competitive ability is dependent upon successful management of the innovation process [4, 8, 13]. However, for many organizations, evaluating the innovation competence is a complex task. For an organization to optimally manage the innovation process, an important challenge lies in measuring the performance of the process.

In the innovation literature, measures of aspects of innovation management are frequently proposed. For example, the literature stresses the importance to measure factors such as innovation strategy, ideas, customer and market, and organizational culture [1, 11]. However, while there has been much focus on innovation and innovation capabilities on an organizational level in the literature, less focus has been placed on a team level. Moreover, according to Adams et al. [1], many organizations

tend to focus on the measurement of innovation to inputs and outputs of the innovation process, but ignore the process in-between.

Innovation is complex and unpredictable [18, 19], which makes measuring the innovation process particular challenging. In particular since practitioners have problems to understand what to measure. That is, to identify the right metrics in order to evaluate the efficiency of the innovation process [1, 7, 24]. One reason for the difficulties of measuring innovation is that important factors of innovation, e.g. knowledge and ideas, cannot be measured directly due to their intangible characteristics [14, 24]. This has led to that organizations rarely track the needed information to evaluate and assess the innovation process in a systematic way. Adams et al. [1] point to the need for both practitioners and academics to measure innovation, and stress the absence of frameworks for innovation management measurements as well as that there are relatively few empirical studies of innovation measurement in practice.

What are the aspects of the innovation process that can be measured in practice? The aim of this paper is to contribute to the measurement theory and practice beyond the focus on measuring inputs and outputs of the innovation process by investigating the process in-between at agile software developing companies. This paper presents the results of an empirical study that includes data collected through in-depth interviews with 28 practitioners from 11 companies in Sweden of which six are multinational. The study focuses on how innovation can be measured in practice, and what metrics can be used to measure a team's innovation capability. This exploratory study can be seen as a study of state-of-practice in industry, but also an investigation as to what extent state-of-the-art in research, in terms of innovation measurement metrics, has penetrated industry practice.

The remainder of this paper is organized as follows. Section 2 presents related work. In Sect. 3 presents the research methodology and discusses the limitations of the study. The results are presented and discussed in Sect. 4, while Sect. 5 gives a summary of the main conclusions.

2   Related Work

The amount of literature on innovation is vast and goes back many years. However, while there has been much focus on innovation and innovation capabilities on an organizational level i.e. innovation processes, as well as on the individual level i.e. entrepreneurship or corporate entrepreneurship, less focus has been placed on a team level. The same accounts for measurement and assessment methods of innovation and innovation capabilities. Furthermore, a majority of innovation metrics focuses on product or process performance and are of a post-hoc character i.e. when products or processes are put on the market or implemented. Popular performance innovation metrics in industry are percent of revenue from new products (NPs), percent of growths in NPs, overall profits generated by NPs [9]. Other popular metrics include number of patents and number of ideas generated in various suggestion facilities.

Measuring climate for work group innovation is something that Anderson and West [3] address. They present a multidimensional measure of facet-specific climate for innovation in group called Team Climate Inventory and pinpoint that *"most previous*

measures of [innovative] climate have evaluated organizations as a whole" [3]. They conclude that by focusing on specific aspect of climate and specific group level outcomes the predictive accuracy is high.

Other sources provide different aspects and dimensions to innovation measurement and assessment. One of the most comprehensive sources is Adams et al. [1] review on innovation management measurements. Based on their review a framework of seven areas for measurement of innovation is provided. They point to the need for both practitioners and academics to measure innovation and stress the absence of frameworks for innovation management measurements as well as *"the relatively small number of empirical studies on measurement in practice"* [1]. Griffin and Page [16] argue that a firm can assess failure or success of development projects by using appropriate sets of measures with alignment to project and innovation strategies. The framework presented by Griffin and Page [16] is relevant when products are placed on the market i.e. post hoc measures (e.g. customer acceptance, market share goals, competitive advantage) and provides mostly insights for innovation on the organizational (firm) level. The same measurement focus can be found in Huang et al. [17] i.e. on firm level and on post-hoc measures. Based on their study on the measurement of new product success in Australian small and medium sized enterprises, it is concluded that firms should use multiple criteria when measuring new product success. The most contributing factors to customer success were in their study found to be customer satisfaction and customer acceptance, hence post-hoc measures.

Davila et al. [12] present another view, based on a business model for innovation with appropriate measures based on four phases; input, process, output, and outcome. For each of these phases they present a plethora of measures. They also define three roles of measurement systems; plan, involving designing and monitoring strategy; monitor, tracking of execution efforts and performance evaluation; and learn, in order to identify new opportunities. Chiesa et al. [6] present a framework for technical innovation audit. Their framework consisting of four core processes: (1) the identification of new product concepts; (2) taking the innovation from concept to launch; (3) the development of innovation in production; and (4) the development and management of technology per se. However, the focus in both [6, 12] is mostly on an organizational (firm) level, hence team-level innovation measurement on climate, processes and performance is not addressed explicitly.

Other literature on measurement of innovation extends the mainstream focus on product and technology by addressing other innovation areas such as service innovation, aesthetic innovation and the measurement thereof. For example, Alcaide-Marzal and Tortajada-Esparza [2] approach innovation and the assessment thereof in industries that are not focused on technological innovation but instead aesthetic innovation. In their review of innovation surveys they especially investigate the occurrence of the following aspects; goals of innovation, inputs to innovation, outputs of innovation, innovation diffusion, and aesthetic design.

While creativity and customer requirements have been addressed in a number of publications how to measure innovation is rather absent in software related literature. Couger [10] uses the work environment inventory to measure the climate for creativity in information systems focused organizations. The MINT framework [22] is, to the best of our knowledge, the only framework that focuses on team level and measurement of

innovation in Software Engineering. The MINT framework [22] consists of four major innovation areas, (1) innovation elicitation, (2) project selection, (3) ways-of-working, and (4) impact of innovation. Each of the four areas consists of a number of factors of how to measure innovation.

3   Research Methodology

The purpose of this study is to gain in-depth understanding of how agile software developing companies measure team level innovation capability, and what metrics could be used, in practice, to measure a teams innovation capability. Innovation is both complex and unpredictable, hence, a qualitative multiple case study approach was chosen because it allows the researcher to understand the studied phenomenon and its context in more depth [25]. According to Burns [5], case studies are an appropriate and often used approach to qualitative research, in particular when the objective of the research is the further understanding of a particular phenomenon that has not been investigated fully, as in this study. The two research questions that provided the focus for the empirical investigation are:

- **RQ1:** How do agile software developing companies measure team level innovation capability?
- **RQ2:** What metrics can be used in agile software development practice to measure team level innovation capability?

3.1   Sample Selection

The sampling strategy used was a combination of maximum variation sampling [20] and convenience sampling [20] within our industrial collaboration network. The researcher contacted a "gate-keeper" at each company who identified subjects that he/she thought were the most suitable to participate in this study. Twenty-eight subjects from 11 agile software-developing companies participated (see Table 1 for number of subjects per company). According to the contacted "gate-keepers", and the 28 subjects, all 11 companies use an agile software development approach in a market-driven software development context. The companies themselves vary in respect to size, type of products, type of customers, and application domain, a characterization can be seen in Table 1 (more details are not revealed for confidentiality reasons).

3.2   Data Collection

The research investigation was carried out using a semi-structured interview strategy [23]. We decided to use interviews over doing a large survey as the concepts of creativity, innovation, and innovation capability are treated very differently in industry, what might be considered creativity in one company is simply adherence to innovation in another. For this reason it was important to have a presence when gathering the data making it possible to elaborate on what we were looking for and compensate for those differences in naming. Moreover, due to the potential richness and diversity of the data

Table 1. Company characteristics

ID	Type of customer	# of employees	Domain	# of interviews
A	B2B	70	Information and technology service	3
B	B2B	3	Data migration	1
C	B2B	100	Control systems	3
D	B2B	24	Wireless connectivity	1
E	B2B	110	Telecom	3
F	B2B	850	Telecom	4
G	B2B	1300	Telecom	3
H	B2B	3000	Telecom	3
I	B2C	5000	Telecom	4
J	B2C	35	Information and technology devices	2
K	B2B	600	Control systems	1

that could be collected, semi-structured interviews would best meet the objectives of this study. Semi-structured interviews help to ensure common information on pre-determined areas is collected, but allow the interviewer to probe deeper where required. In addition, the interviewer had the chance to validate the questions with the interviewee lessening changes of misunderstandings. That is, the interviewer went back to the interviewee to validate the interviewers interpretation of the results to minimize misinterpretations and to validate the results.

The research instrument (see Table 2) used in this study was designed with respect to innovation, innovation capability, and innovation metrics. One interviewee and one interviewer attended all interviews. During the interviews, the purpose of the study and explanations of innovation were presented to the interviewee, followed by questions about innovation, innovation capability, and metrics were discussed in detail. Several times we had to put five to ten minutes of explanation what we were investigating, what is innovation (the introduction of a product/feature/service, or production/delivery method including software development processes and practices, that is new or significantly improved with respect to its characteristics or intended uses) and innovation capability (the overall capability/capacity encompassing the ability to absorb, adapt, and transform ideas into new products/processes/features/systems) before the interview subject understood and we could proceed. This was done in order to make sure that the interviewees and we had the same understanding of the key concepts of the study. For all interviews, varying in length from 40 to 60 min, we took records in the form of written extensive notes in order to facilitate and improve the analysis process. Due to confidentiality reasons, and non-disclosure agreements with all participating companies and participants, the data (that is, the written extensive notes) cannot be disclosed.

Table 2. Interview instrument

Characterization	Tell us about the company
	Tell us about the company's products
	Tell us about your role at the company
Innovation	How do you know that you and your team are innovative?
	Do you measure the innovation capabilities of a team? If so, how and what metrics are used?
	According to you, what aspects of innovation capability can be measured?
	What aspects of innovation can be helpful in industry?
Final question	Can you think of anything else that we have not covered that you think we should have asked?

3.3   Data Analysis

In the data analysis phase, the data from the written extensive notes was analyzed using content analysis [23] based on the interview instrument. Content analysis is a method for analyzing and interpreting data [23]. The focus of content analysis is to gather information and generate findings. The gathered information (content) can be any written information and different categories containing content are constructed for analysis. The content analysis involved marking and discussing interesting sections in the written extensive notes. The chunks of text from the written extensive notes were placed within the relevant sections (corresponding to a team's innovativeness, innovation capability and innovation measurements). These were numbered and relationships were captured by identifying dependencies to and from each category.

Based on the results from the content analysis, three main categories of innovation emerged, namely: (1) *How ideas are created and/or found*; (2) *prioritization of new ideas*; and (3) *innovation efforts*, which includes more 'traditional' innovation measurements such as patents and return on investment. The meaning of, and the results related to these three categories are reported in Sect. 4.

3.4   Limitations

For this study, as for any empirical study, there are limitations to discuss and address. The threats to description and interpretation validity and steps taken to mitigate them are reported herein, and the generalizability of the results is discussed. The limitations are described based on guidelines for flexible designs provided by Robson [23].

Description validity: The two main threats to description validity is the risk of participants not freely expressing their views during the interviews and the risk of misinterpreting what is said. To mitigate the risk of participants not freely sharing their opinions each participant was guaranteed company internal and external anonymity. Concerning the risk of misinterpretations, written extensive notes were taken during the interviews. These notes were used when making transcriptions of the interviews and were sent back to the participants to check that they correctly reflect what was said at the interviews.

Interpretation validity: The main threat to providing a valid interpretation is that of imposing a framework or meaning on what is happening rather than this emerging from what is learnt during the involvement with the setting. However, this does not preclude starting with a set of predefined categories, but these categories must be subjected to checking of their appropriateness, with possible modification. In this study, the threat of interpretation was managed by discussing the researcher's final interpretation of the interviewee's answers with each of the 28 interviewees.

Generalizability: Considering generalizability, the results are limited to the included case companies. However, qualitative studies rarely attempt to generalize beyond the actual setting since it is more concerned with characterizing, explaining and understanding the phenomena under study. The nature of qualitative designs also makes it impossible to replicate since identical circumstances cannot be recreated. However, the development of a theory can help in understanding other cases and situations. The fact that more than one participant and company acknowledge several of the discovered results and challenges increases the possibility of transferring the results to other situations. The large number of companies and contexts also contributes to generalizability. To avoid the interaction of selection and treatment, interviewees were selected by a gate-keeper at each company, hence the researchers did not select the subjects themselves. Moreover, companies were selected from different geographical locations.

4 Results and Analysis

Innovation management measurement is an important discipline for practitioners. An organizations capacity to innovate is determined by several factors, both relating to their own internal organization as well as to their market environment. The task of generating, and then, converting creative ideas into usable marketable products requires high levels of inter-functional coordination and integration.

An overview of the results from the interviews is shown in Table 3. In Table 3, we have mapped the empirical findings from each participant from each company (A-K in Table 3) to three main categories of innovation measurements at team level based on, how do the practitioners know if a team is innovative (*'How to know'* in Table 3), how do the practitioners' companies and teams measure their team's innovation capability today (*'Currently measuring'* in Table 3), and what metrics do the practitioners think could be used in practice to measure a team's innovation capability (*'Could be measured'* in Table 3). The three main categories of innovation that we identified are: (1) *How ideas are created and/or found*, which includes if the ideas internally and/or externally collected and generated; (2) *prioritization of new ideas*, which focus on the prioritization of the newly generated/created/discovered ideas into actual projects; and (3) *innovation efforts*, which includes more 'traditional' innovation measurements such as patents and return on investment.

If a company has an 'X' in both the category "currently measuring" and in "Could be measured" in Table 3, that means that one interviewee stated that they currently measure this, while another interviewee stated that this could be measured. That is, the interviewees from the same company had different understandings of what they

Table 3. Overview of how to know if a team is innovative, what is currently measured, and what metrics could be used to measure a team's innovation capability

	Companies											#
	A	B	C	D	E	F	G	H	I	J	K	
How to know												
How ideas are created and/or found	X		X		X	X		X	X		X	18
Prioritization of new ideas												0
Innovation efforts			X	X			X	X		X	X	11
Currently measuring												
How ideas are created and/or found					X	X	X	X				11
Prioritization of new ideas			X									3
Innovation efforts			X	X		X	X	X	X	X	X	17
Could be measured												
How ideas are created and/or found	X	X	X		X	X	X	X	X	X	X	24
Prioritization of new ideas			X									2
Innovation efforts			X	X	X	X	X	X	X	X	X	10

currently measure. The second main category, *prioritization of new ideas*, was only identified among the interviewees for what they currently measure and what they believe could be measured. Hence, the reason for the count of "0" under **How to know** in Table 3. The reason for including this category under **How to know** was to show that none of the interviewees stated that prioritization of new ideas can be used to know if a team is innovative or not. The column '#' in Table 3 shows how many of the 28 participants that identified a measurement in each category. A more detailed description of each of the categories is presented in the following sub-sections.

In Table 3, we can see that Company A can identify a team's innovation capability by measuring factors related to how the ideas from the team are created and found, Company E currently measure factors in relation to how ideas and created and/or found to identify a team's innovation capability, while the participants from Company F believes that metrics related to innovation effort could be used to measure a team's innovation capability.

Looking into how to know if a team is innovative or not, seven companies, and 18 out of 28 participants, identified factors related to how ideas are created and/or found, six companies, and 11 participants, in the innovation effort category, while only two companies (Companies C and H) and four participants identified both how ideas are created and/or found and innovation efforts. That how ideas are created and/or found was seen as a possible way to measure a team's innovation capability is not surprising since measuring the performance (i.e. how ell they perform an activity/task) of the organization – regardless of which level (project/product/company) – has been identified in previous studies (e.g. [1, 2, 6, 12, 22]) as a measurement of innovation.

The following two sub-sections present and discuss one research question each, corresponding to the research questions in Sect. 3.

4.1 Measure Team Level Innovation Capability (RQ1)

Looking into how agile software developing companies currently measure a team's innovation capability, 18 participants from six companies stated that they currently use number of granted patents to measure a team's innovation capability, while four participants from three companies mentioned number of submitted patent applications, as illustrated in Table 4. This result is in line with the findings from Adams et al. [1] and Crossan and Apaydin [11]. Although several interviewees from several companies mentioned number of granted patents and number of patents applications, none of the participants believe that patents is a good measure for a team's innovation capability, or that the number of patents tell the whole truth about a team's innovation capability.

One participant from Company F explained that *"number of patents could give some indications, but it does not tell the whole truth. We have several innovations in our products that are not patented"*. Another participant (Company H) explained, *"number of granted patents and patent applications may be a decent start, but there are many companies that come up with innovative products that are not patented"*. Besides not taking patents on new innovations, the patent process itself may be a hinder for creativity and new innovations. One participant from Company G explained that the patent process is a hinder for innovations. The participant further explained, *"I had a new idea that I found extremely interesting and we decided to write a patent application. The whole process of rewriting the idea with a patent engineer made my idea so generalized that I did not recognize it anymore. After this experience I lost my ambition to come up with new innovative ideas"*.

That Company B does not measure innovation capability by number of granted patents or number of patent applications, nor sees it as potential metrics that could be used to measure a team's innovation capability (see Table 5 in Sect. 4.2) is not surprising since the patent application process is both expensive and time consuming, which was supported by the participant. Another participant shared the same view, *"the whole process of writing a patent application took so much time that I felt it is not worth it anymore"*.

Looking into Table 4, we see that three companies (E, H and I) use number of collected ideas from key stakeholders to measure a team's innovation capability (for Company H and I, in combination with number of granted patents), while two companies (F and G) use number of generated ideas by the team. To measure number of generated ideas by the team, the participants from the to companies mentioned three different ways of encouraging the teams to generate new ideas. First, encouraging the employees to generate new innovative ideas for an internal or local innovation competition. For each year, both of the companies participate in innovation competitions and then it is possible to measure number of submitted ideas to the competition from each team. Second, both companies mentioned that they measure number of generated ideas by the team in general. Third, one company use the metrics of number of new solutions to existing problems to measure a team's innovation capability.

Company G is the only company that currently uses number of generated ideas from third party (i.e. sub-contractors, eco-systems, and open innovation) to measure their team's innovation capability. In addition, Company G is the only company that

Table 4. Detailed view on what is measured today

	Companies											#
	A	B	C	D	E	F	G	H	I	J	K	
How to know												
Number of collected ideas from key stakeholders			X		X	X						9
Number of generated ideas by the team					X	X						3
Number of generated ideas from/based on third party	X		X		X	X		X	X		X	14
When a feature is wanted by the customer										X	X	3
Number of granted patents			X	X			X	X				8
Number of patents applications			X	X			X	X				8
Currently measuring												
Number of collected ideas from key stakeholders					X			X	X			4
Number of generated ideas by the team						X	X					4
Number of generated ideas from/based on third party							X					1
When a feature is wanted by the customer										X	X	3
Return on Investment			X									3
Number of granted patents			X	X		X	X	X	X			18
Number of patents applications			X	X			X					4

Table 5. Detailed view of what could be measured

	Companies											#
	A	B	C	D	E	F	G	H	I	J	K	
Could be measured												
Number of collected ideas from key stakeholders	X	X	X									7
Number of generated ideas by the team					X	X	X	X	X			7
Number of generated ideas from/based on third party					X	X	X	X	X	X	X	20
When a feature is wanted by the customer										X	X	3
Return on Investment			X									3
How much each team's features/products sell for										X	X	3
Pre-release to key customers	X	X	X									7
History of number of innovations					X		X	X				6
History of number of generated ideas that led to new innovations					X	X					X	5
'Gut-feeling'	X	X	X		X	X	X	X	X	X	X	26

uses more than two (they use four metrics, see Table 4) metrics today. No further elaboration was given of why they used four metrics.

When a customer wants a released feature is used by two companies (J and K) as a metric (how many times this happens) to measure a team's innovation capability. One participant from Company J explained that "*it is difficult to measure before a product is released. You are measured in comparison to your competitors – if you have a new feature or enter the market first with something new, then you have proof for innovation*".

To our surprise, only companies (E, F, G, H, and I) from the telecom and mobile domains, which is all of the companies in the telecom and mobile domain, are currently using any metrics from the category *'How ideas are created and/or found'* (see Table 3) to measure a team's innovation capability. One explanation may be that this way of measuring a team's innovation capability is domain related. However, another more likely explanation may be related to the size of the company. The five telecom and mobile companies are the largest companies, in terms of number of employees, among the participating companies in this study.

One interesting finding in what is currently used to measure innovation capability is that Company C is the only company that uses any factor from the category *'prioritization of new ideas'* (see Table 3). The metric being used by Company C in the *prioritization of new ideas* area is estimated return on investment, which is in line with the popular performance innovation metrics in industry identified by Cooper et al. [9]. No further elaboration was given of how and why estimated return on investment is used to measure a team's innovation capability.

The results show that Companies A and B do not measure a team's innovation capability at all. The reason for Company A not to measure innovation was explained by all three participants, *"it is not possible to measure innovation and measurement frameworks do not provide an overall picture of our innovation capability"*. For Company B, one participant explained, *"no, we do not do this, but perhaps it is possible. However, I think it is too complex and it will not give us an overall picture. In addition, it takes too much time and since it will not give us a true picture, it is not worth it"*. The time aspect is important in agile software developing companies due to the short sprints where a company should deliver a working software product within 2–4 weeks. Another possible explanation of why Company B does not measure innovation capability could be that it is a small company with only three employees. The complexity of measuring innovation capability that is described by companies A and B is in line with the findings in McCarthy et al. [18] and Murray and Blackman [19].

In summary, to answer RQ1, the results show that seven metrics are currently used in practice to measure a team's innovation capability. The seven metrics that are used in practice today are:

- Number of ideas from key stakeholders
- Number of ideas generated by the team
- Number of ideas generated from third parties
- When a feature is wanted by the customers
- Return on investment
- Number of granted patents
- Number of patent applications

Currently, 6 of the 11 companies use number of granted patents to measure a team's innovation capability, which makes this metric the most used ones in practice. To use number of patents to measure the innovation process is in line with previous findings from Adams et al. [1] and Crossan and Apaydin [11]. However, none of the participants believed that number of patents are particular useful in determining a team's innovation capability.

4.2   What Could Be Measured (RQ2)

In analyzing research question 2, what metrics could be used in practice to determine a team's innovation capability, we see that the most frequently mentioned "metric" was 'gut-feeling', which was mentioned by 10 out of 11 companies, and by 26 out of 28 participants (see Table 5). Several of the interviewees explained that measuring innovation, in particular at team level, is highly subjective and that the output from an innovation measurement framework, or most of the other innovation metrics would be highly uncertain. Therefore, using ones 'gut-feeling' to determine a team's innovation capability was considered more reliable than most 'hard' metrics. This result may be related to the result of RQ1 (see Sect. 4.1), where the participants expressed that measuring innovation, and a team's innovation capability is very difficult, if not impossible. This result is not in line with any previous studies in innovation measurement in general, nor in studies focusing on innovation in software engineering (see Sect. 2 for example of previous studies in the field). One possible explanation for why 'gut-feeling' was considered the most useful metric may be related to that measuring the performance of a team's innovation capability is not seen as important during product development.

Looking at Table 5, we see that the participants from companies (E-I) in the Telecom and Mobile domains believe that the number of ideas generated by the teams is a good metric to use. Moreover, the five companies (E-I) from the Telecom and Mobile domain together with two other companies (J and K) believe that number of generated ideas from/based on third party is a good metric to use when measuring a team's innovation capability. With third party, some participants referred to sub-contractors, a few mentioned ideas that were generated from the use of Open Source Software, but most of the participants (14 our of 20, see Table 5) explicitly mentioned Open Innovation. That is, most of the participants believe that a good way to measure the innovation capability is to count the number of ideas that have been generated due to participation in Open Innovation.

Using number of generated ideas as a way to measure innovation is in line with the finings from Adams et al. [1], Crossan and Apaydin [11], and Regnell et al. [22]. However, using Open Innovation as part of measuring innovation capability in general, and particularly at team level has not been reported in previous studies. On the other hand, the participants from companies A, B, and C believe that number of collected ideas from key stakeholders, and pre-release to key customers could be measured to determine a team's innovation capability. One hypothesis may be related to the market and type of customers. For the companies in the Telecom and Mobile domains, the market and the customers may be pushing for new innovations and therefore externally generated ideas could be used to measure the innovation capability. Moreover, if the market "pushes" the companies to generate new innovative products and features, this

may stimulate the employees to internally generate new ideas, hence it could be used to measure the innovation capability.

Two interesting metrics for measure innovation are using the history of a team's number of innovations (companies E, G, and H), and to use the history of how many of the generated ideas actually led to real innovations (companies E, F, and K). One participant explained, *"if a team has generated 20 ideas, of these 20 ideas, 10 led to the creation of prototypes/mockups, while only 1 of these 10 prototypes/mockups actually became an innovation, then we can use this data to measure each team's innovation capability"*. The participant further explained the benefits of measuring these kinds of metrics, *"this provides the managers with some indications of how many ideas each team must generate to get one new innovation"*.

For Company D, no metrics were identified that could be used to measure a team's innovation capability. Although the participant from Company D believes that number of patents could, to some extent, be useful for other things, the participant believes that it is not possible to measure the innovation capability in general, nor by using number of patents. The participant explained, *"to measure number of patent applications could give some indications to some things, but it does not tell the truth about innovation or innovation capability. A team's innovation capability is based on very subjective measures and therefore it is not a very reliable measure. It is not worth the effort considering how unreliable the measurement will be. Therefore, I do not believe that there are any metrics that you can use so it would be useful in practice"*.

None of the 11 companies mentioned any metrics or possible way of measure a team's innovation capability that could be mapped to '*ways-of-working*', that is related to the process of innovation, organizational abilities, the innovation climate, or continuous process improvement. Although, for example, organizational climate factors have been shown to be important for creating an innovative organization [15], these factors can only stimulate creativity and innovation, but may not be able to measure how innovative a team is.

None of the participants mentioned granted patents, or number of patent application as metrics that could be used to measure the innovation capability. This result is in line with the participants view (see RQ1 in Sect. 4.1) on that patents are not a good metrics to use to determine the innovation capability.

In summary, the results show that the participants believe that some metrics can be used in practice to measure a team's innovation capability. The most frequently mentioned metric was 'gut-feeling', followed by number generated ideas from third parties, especially number of ideas that have been received from participating in Open Innovation.

5   Conclusions

In conclusion, this paper presents the results of an empirical study that examines how a team's innovation capability in agile software developing companies is currently measured, and what metrics could be used in practice to measure the innovation capability. Data are collected from 28 participants at 11 agile software developing companies.

In relation to RQ1, what metrics are currently used in practice to measure a team's innovation capability, the overall result indicates that relatively few metrics are used in practice to measure the performance of the innovation process at team level. The two most used metrics in practice are number of granted patents and number of patent applications; however, none of the participants believed that patents could be used to measure a team's innovation capability. In addition to patent, the only other metrics used in practice are, number of ideas from key stakeholders, number of ideas generated by the team, number of ideas generated from third parties, when a feature is wanted by the customers, and return on investment.

The relatively few metrics used in practice to measure a team's innovation capability may be an indication that innovation is complex and unpredictable; hence, it is difficult to get a reliable measure of a team's innovation capability. Another possible explanation may be that innovation is not prioritized in practice, which may be because of the agile development process. That is, the short sprints with a focus on delivering a working product may force the practitioners to solely focus on implementing features that the market wants and that their competitors already have implemented, hence the companies are more focused on following others rather than inventing new ideas to gain competitive advantage.

In relation to RQ2, what metrics could be used to measure a team's innovation capability, the findings reveal that 'gut-feeling' is the most frequently mentioned metric. 'Gut-feeling' is seen as at least as reliable as any other innovation measurement frameworks. The second most frequently mentioned metric was number of generated ideas from/based on third parties, where generated ideas from participating in Open Innovation was the most frequently mentioned one.

The main problem is that measuring the performance of the innovation process are not seen as important during product planning and development, making the realization of new innovative products/features a reactive (i.e. identify competitors new innovations and follow them) rather than a proactive effort to gain competitive advantage. The companies may thus not be able to rely on the innovation capacity to achieve competitive economy.

Further research is encouraged to investigate other industries in order to establish how innovation capabilities are measured. Furthermore, based on the results from our study, a broad survey, involving more companies from different parts of the world could also provide interesting if the pattern found in this study is similar in the wider scope of software based companies.

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