

IT Competency Evaluation: A Case Study

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Abstract—IT consulting companies must be able to select the best suited developers for their clients. A method of doing this is through competence evaluation. Sigma IT Consulting uses an excel sheet for the employees to fill in their competence. Problems such as data inconsistencies in competency excel worksheets might cause difficulties for managers while making decisions to assign right developer to the right job. Such difficulties may lead to frustration in managers and hence cause more problems in their decision-making process. Transition to web-based competency platform may solve these problems for managers. The case study will consist of three phases. The first phase will consist of elicitation and investigation, its main goal is to pin point some key features that the new web-platform should contain as well as identify the opinions of the employees at Sigma IT Consulting on measuring competency. The second phase is the development phase, where the web-platform will be developed. The third and final phase is the evaluation phase, where the effect of the new system on the emotions and motivation of the employees is evaluated. The results concluded that the partial automation of the web-platform has a positive effect on the employees emotion and motivation regardless of the role.

I. INTRODUCTION

A. Statement of the problem

IT consultant companies work on developing software in a large variety of programming languages, therefore it is of utmost importance to identify which developers to choose for a team that will best serve their client. To address this problem, companies such as Sigma IT Consulting came up with a competence sheet that can be used to rank the employees based on programming knowledge and soft skills. The definition of soft skills is “Personal attributes that enable someone to interact effectively and harmoniously with other people” [1] such as knowledge of working in a software development project. Companies such as Sigma IT Consulting use Excel Sheets to keep track of the employees knowledge in software engineering which is filled in manually by the employees and evaluated manually by the project managers. By conducting research, we were able to identify issues and disadvantages of the current solution in regards to technical and psychological aspects, such as low motivation due to a large amount of time being used to update and evaluate their competence.

To address these issues, a competence platform that can address these issues must be developed. The research data was collected through qualitative and quantitative means, in order to ensure that the platform that was created addressed the problem of rating the developers knowledge in a different and more satisfactory method by partially automating the excel competence sheet. The web-based competence platform also offers a profile feature where it suggests a method for an employee to improve any of their programming languages or soft skills through a ‘Learn more’-feature. The effect of the system were evaluated quantitatively in order to understand its influence on the developers/managers motivation and emotions.

B. Importance of research

The purpose of this study is to research how technical competence is put into practice at a software engineering consultant company and compare it to existing solutions in literature that are proposed to assign the right person to the right job. Moreover, we investigate the advantages and disadvantages of turning a competence sheet into a web-based platform from the perspectives of managers and employees.

Managers use the competence platform to assign the right employee to the right task, while employees can use the platform to monitor the progress of their technical competence levels as well as using it as a guide to identify the skills/knowledge they need to acquire to improve their technical competence. Such usage of competence sheets may affect the motivation and emotions of the employees (i.e., developers). Motivations of software developers has long been studied [2] [3]. Research in cognitive science shows that there is a relationship between emotions and motivation. According to Franklin and Ramamurthy [4] “Motivations prime actions, values serve to choose between motivations, emotions provide a common currency for values, and emotions implement motivations.”. Emotions affect the decision making of the managers and also the performance of developers. Recently, there is a significant increase in the interest of software engineering research community in the concept of emotions. This trend can also be observed through workshops such as “International

Workshop on Emotion Awareness in Software Engineering” (SEMotions), which was first organised in 2016 as a part of the International Conference of Software Engineering (ICSE) that is the premier conference in software engineering. In the literature, there is empirical evidence that positive emotions such as “happiness” cause increase in developer performance [5], while negative emotions such as “frustration” have negative effects on performance [6].

Current problems such as data inconsistencies in competency excel worksheets might cause difficulties for managers while making decisions to assign right developer to the right job. Such difficulties may influence the emotions and motivation of the managers negatively and hence cause more issues in their decision-making process. Transition to a web-based competency platform may solve these problems for managers. On the other hand, this may cause negative emotions and stress among software developers as managers might start using the competency platform to evaluate performance of developers and offer promotions based on those evaluations. This might result in positive emotions in some developers, since the platform will reflect their competency properly and hence they will be assigned to jobs they that they have the right competence for. In order to investigate these mentioned possibilities and also further regarding emotions and motivations of developers and managers, we will conduct semi-structured interviews before and after completion and introduction of the semi-automated web-based competency platform to managers and developers.

C. Research Questions

The main research question and the sub research questions below aim to address the technical and psychological aspects of competence evaluation in software engineering consultant companies.

- **RQ 1:** How is technical competence within software engineering evaluated at a software engineering consultant company and how does partial automation change this?
 - **RQ 1.1:** How does Sigma’s evaluation of technical competence within software engineering compare to approaches for evaluating technical competence from the literature?
 - **RQ 1.2:** How does partial automation of the competence evaluation platform affect emotions and motivations of developers and managers?

To to be able to answer RQ 1.2, the following sub-questions must be answered:

- How do the current competency excel worksheets affect the motivation of software developers?
- How will transition to semi-automated web-based competency platform affect motivations of software developers?
- Do the problems in current competency excel worksheets (e.g., data inconsistencies) cause negative emotions such as ‘frustration’ in managers?
- What kind of emotions are likely to arise in developers due to the transition to web-based competency platform?

- What kind of emotions are likely to arise in managers due to the transition to web-based competency platform?

II. BACKGROUND & EXISTING LITERATURE

A. Case company description

The company involved in this case study is Sigma IT Consulting Company, more specifically a team of 30 developers/managers called MyTeam. Sigma IT Consulting is an international consultant company in software engineering sector and its headquarters is in Gothenburg, Sweden. Sigma IT Consulting has the highest number of branches in Sweden among the Swedish IT consulting companies and they are active in 20 locations in Sweden. The company is also expanding internationally, and it has in total 200 employees who are specialized in IT/software development and/or management. The developers in the company view themselves as programmers that are both passionate about programming and effective in delivering their software products. Sigma IT Consulting is a daughter company of Sigma [7]. There are many sister companies to Sigma IT Consulting that work in a similar field such as Sigma Technology, Sigma Software, Sigma Connectivity, Sigma Civil, and (The owner of the Sigma Group) Danir AB. Sigma has a total of 3000 employees, as of the year 2016 [8]. Sigma IT Consulting offers their employees training services in order to increase their knowledge and skills in various programming languages.

The company is currently using a competence sheet to evaluate the technical knowledge and soft skills of its employees, they started using it about a year ago. The problem is that this is done in a very manual manner which is not very effective since the employees need to email the sheet to their supervisor/boss every time they update it. Some of the employees have a hard time locating their previous sheets which causes them to waste more time refilling the excel sheet again. If the supervisor finds a problem with the sheet (s)he must email the sheet back to the employee and then the employee will update the sheet and email it back to the supervisor. This process is rather tedious and results in a lot of time being wasted as well as leading to data inconsistencies and thus decreasing the reliability and trustworthiness of the information in the sheets. The excel sheets also contain a note section where some links and text can be found in regard to basic approaches that the employees can take to improve their level. However, these basic approaches are not customized according to employees’ current levels of the programming knowledge and skills. This leads to the problem of further time wasting as the employees need to figure out which information applies to them and they are therefore forced into exploring everything.

Because of the problems mentioned in the previous paragraph, there is a need for the development of a partially automated competence platform. The platform will make it more convenient for developers to rate their knowledge in various programming languages, it will also offer a profile page where it will make a recommendation to employees about

how they can improve their knowledge and skills in any of the programming languages depending on their current levels.

B. Existing literature

Competency based assessment is one of the most central concepts when it comes to **understanding why** competence evaluation is conducted from a managerial standpoint. Gonzi et al. argues that by identifying the technical and psychological competencies required to perform a task efficiently and matching them with the competencies possessed by the employees, managers can ensure they use their employees to their fullest potential. This is true for both assigning your employees assignments as well as looking for new potential employees to recruit based on where there is a gap in the current competency [9].

There is plenty of tangential research mentioning **how** and **why** competence in software engineering can be evaluated in companies. However, there is lack of research when it comes to exploring **how it is** actually being evaluated in consulting companies.

The complexity of software is increasing and the emphasis on quick delivery has been increasing in the field of software development [10]. Therefore, it is important for IT employees to have high core competence to land jobs in competitive firms [10]. In other words, if an organization that is based in the IT-field wants to succeed, it needs to employ people with high competency. Competency of employees will include soft and technical skills [11].

Hamel and Prahalad define core competence as “the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technology” [12]. These works make it clear that measuring the competence of the employees is important to the managers and the organization as a whole.

Burgess et al. state that measuring competence is also important for the employees of an organization since it allows them to reflect on their own skills and critically evaluate them and decide which ones that they could improve further and which ones are their strong points [13].

Some studies state that the competence of the employees does not consist of purely stating your technical skills, but also the ability to solve abstract problems. According to Bergersen and Gustafsson, when employees are faced with a programming problem they cannot rely solely on their knowledge of the programming language, but they must also rely on their ability solve abstract problems [14]. This is further studied by Adelson who concludes from both qualitative and quantitative data that novice software engineers tend to use a more syntax-based problem solving technique, while experienced software engineers tend to have an abstract hierarchical technique [15]. This is a reoccurring theme when it comes to the correlation between being efficient in the sphere of programming and being able to solve abstract problems. Lahtinen et al. argues that novice programmers might have no problem understanding mathematical concepts but struggle with programming when it comes to abstract problems like memory handling [16].

There are different ways to measure competency. When trying to measure programming skills a study suggests that an extensive questionnaire where employees fill in their year, level estimation, years of experiences and the size of projects [17]. This questionnaire focuses on evaluating the developer programming skills as a whole, but used only “Java, C, Haskell and Prolog” as a base for the rating rather than ask them about specific programming languages to understand their level of experience per programming languages [17]. An extension of this paper uses a similar approach with the addition of some questions that explore how they compare their experience with people that have been in the field over 20 years [18].

Knowledge management within software engineering is closely related to the research contained in this paper and presents the foundation for the research. It covers capturing the technical knowledge and who knows what as well as what can be done to increase the knowledge [19].

A study examines the effect of trust on the competence of the employees [13]. The study concludes that a system of trust that promotes the employees to be honest about their skills is an important base for an IT consulting company.

We can conclude that the subject of competence in software development is rather difficult to quantify. There are many aspects that make a developer good. When faced with a problem that must be solved using a programming language, it is best to hire a developer that is familiar with such knowledge. However, the ability to solve an abstract problem is another factor which is of equal importance [14]. Therefore, it is important to investigate what is the best method to tackle the topic of measuring competence inside an IT consultant company.

Akgun et al. argue that potency within development teams has positive effects on key properties such as speed-to-market, development costs and market success [20]. Potency in this case consists of having developers with the appropriate competence for position in question. This is crucial when assigning roles and tasks within the development team as argued by Acuña and Juristo [21].

Cognitive aspects such as emotions, stress also have their place when performing competence evaluation when it comes to team building and management within software engineering. As addressed by Chilton et al., ability to manage stress and strain to ensure productivity could be seen as a competence soft skill that is highly valuable to have in addition to the technical competence required for the position [22]. This is further argued by Acuña and Juristo in another study claiming that soft skills can sometimes eclipse the technical skills when it comes to competence in software development [23]. This further emphasizes the importance of the psychological aspects such as reasoning or openness to change when evaluating competence in software engineering consultant companies for this study.

III. RESEARCH METHODOLOGY

This study was performed as a case study, which consisted of three main phases, which are investigation and elicitation,

development, and evaluation, respectively. This case study that the researchers conducted helped gain insight about how competence evaluation is performed in IT industry as well as allowing the researchers to compare current solution of Sigma IT Consulting to the existing approaches in literature. In addition to this, we were able to observe the effects of the partial automation of the competence platform on emotions and motivations of company's employees.

One of the main reasons for conducting a case study [24] over design science or experiment, is because the scientific contribution here is not the implementation of the web-based competency platform, but the evaluation of emotion & motivation. It also allows the researchers to compare how competence is being measured at Sigma IT Consulting to how competence is measured in previous literature, instead of using design science to solve a concrete problem. This will also help the researchers determine if there are any benefits to partially automating the competence evaluation sheet.

The data collection was gathered through qualitative and quantitative approaches in the form of interviews and user studies. This allowed the researchers to obtain a deeper understanding over the problem of measuring competence and the effect of a partially automated competence sheet on the emotions and motivation of the developers and managers.

A. Phase 1: Investigation & Elicitation

This phase is of utmost importance since its main purpose was to confirm the requirements that were supposed to be provided by Sigma IT Consulting. However, due to unforeseen circumstances the researchers had to instead extract the requirements from the competence sheet and additional requirements were obtained through interviews. The interview questions were initially evaluated through a pilot interview. This made sure that the questions asked during the actual interviews were relevant, easy to understand and relate to the research questions [25]. Interview questions and data of the pilot interview are given in Appendix A and Appendix B, respectively.

Interviews were conducted with 8 employees out of which 2 were managers and 6 were developers. Some of the employees have either been part of creating the initial sheet, developer filling in their competence or managers using the sheet to assign employees to tasks. The data collected from the interviews were transcribed and then coded by extracting the key points mentioned in the interview [26]. The data collected were then be iterated over by using classification, to group similar answers together. Analyzing this data taking the frequency of common answers into consideration it was possible to see what needed to be focused on [27].

The interview was aimed at collecting data that was necessary for the creation of the competence platform. Therefore, it mainly focused on the thoughts of the employees about the competence sheet that as well as their opinion of its accuracy and weaknesses. It also focused on the social problems of the competence sheet such as how they feel about being evaluated. The interview contains follow-up questions depending on the

role of the employee to make sure that the responses obtained are relevant to the role of the interviewee.

The interviews consisted of three parts. first part of the interview helped the researchers identify different ways the competency sheet can be used depending on employee's role. Since project managers, and architect in the company also develop software and also use the competency sheet in the same way as developers do.

The data in the second part of the interview aimed at the helping the researchers obtain the knowledge of the employees in regard to how competence is handled in the field of software engineering and in software companies in general..

The third part of the interview aimed to find out what managers and developers think about the automation of the competency sheet into a web-based platform.

Using information obtained through interviews from managers and developers at Sigma IT Consulting, the researchers compared how employees views on measuring competence differ depending on the employees role in the company. The questions that were most helpful are:

- 1) What do you think about the current way of keeping track of and updating the competence sheet?
- 2) What are your thoughts about turning the competence sheet into a web-based system?
- 3) Are there any special features that you would like to have if the web-platform is to be implemented?

B. Phase 2: Development

In this phase development of the prototype for automated web-based competence platform was completed. The main requirements for the development phase were extracted from the current solution in addition to using the data collected from the interviews as mentioned in the previous phase. Using this information to develop the prototype the requirements were broken down into the tasks.

Regarding the architecture of the web-based automated competence platform, constraints were provided by Sigma IT Consulting and a result the skeleton of the prototype is set up with a back-end REST API written in ASP.NET Core and Entity Framework Core with SQL Server as the database. The front-end is a Single Page Application(SPA) [28] written in Angular 2. The back-end API acts as an intermediary between the database and the front-end by handling HTTP requests and giving the proper response [29]. The researchers created an overview of the system that can be seen in Figure 1. A larger version of the figure can be found in Appendix B

An agile approach using SCRUM [30] was used throughout the development phase. Each sprint lasts for 2 weeks and started with a sprint meeting and ended with a sprint review. The tasks for the prototype were put in a backlog that was used to supply each sprint with tasks depending on velocity and priority. At the end of each sprint the resulting solution were analyzed and new tasks chosen for the next sprint.

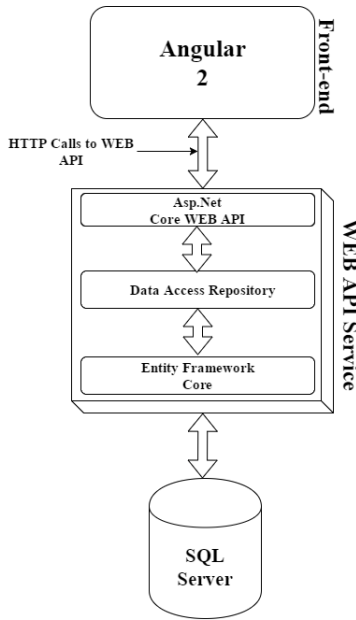


Fig. 1. System Architecture

C. Phase 3: Evaluation

In order to evaluate how the prototype of the web-based competence platform we developed compares to the competence sheet, and how developer's and managers' emotions and motivations are affected by this partial automation, we conducted a user study with each participant. During the user study, we conducted a Self Assessment Manikin (SAM) [5] and an Intrinsic Motivation Inventory (IMI) [31] to collect quantitative data about the participant's emotions and motivations. This quantitative data was complemented by qualitative data obtained from think aloud protocols that were applied during the user study, by making the participants explain their reasoning behind the statements they selected and the decisions they make.

Before the user study with each participant, we presented the demo to the the participant. The demo session included the functionalities and features of the web-based competency platform prototype and showed how it can be used.

The user study consists of the following phases:

- 1) Explain the task with the competency sheet to the participant and let the participant perform the task. Ask the participant to think aloud while performing the task.
- 2) Conduct SAM.
- 3) Conduct IMI.
- 4) Explain the task with the web-based competency platform and let the participant perform the task. Ask the participant to think aloud while performing the task.
- 5) Conduct SAM.
- 6) Conduct IMI.
- 7) Conduct a small interview with follow-up questions.

Out of 8 participants, randomly 3 participants were selected and the order of the phases 1) and 4) were swapped for those participants. The aim of such swapping is to reduce mere-exposure effect that affects how a person views something that

they are not familiar with [32]. The further details of the user study protocol can be found in Appendix F. Below we explain the main components of the user study, which are 'Demo and Tasks', SAM and IMI, respectively.

1) *Demo & Tasks*: As mentioned previously, developers and managers use competency sheets in different ways to perform different tasks. Therefore the demo session for the web-based competency platform prototype as well as the tasks with the competency sheet were conducted differently depending on the role of the participant (i.e., manager or developer.).

While conducting the task with the developers, the researchers asked the developers to mimic the process of updating their competence as they would do if their manager asked them. The main goal in doing this was to ensure a realistic setting while conducting the task. For this purpose, while conducting the task with competence sheets, the developers were provided an email client where they would download a copy of the competence sheet. Developers were then asked to update their competence for five areas of programming and soft skills. These fields were randomly selected by the researchers. Once the developers filled in the sheet, they were asked to send it as an attachment via email by replying the initial sender of the sheet. During the task with the web-based platform, the researchers asked the developers only to fill in five fields of programming and soft skill that were randomly selected by the researchers.

Regarding the tasks for managers, the researchers asked the manager to mimic the process of creating a new profile and adding five random programming and soft skills to that profile. The manager was then asked to search for developers who matched the created profile. The managers were asked to perform this task both with the competency sheet and the web-based platform.

The participants used the think aloud technique [33] when performing the tasks in order to give the researchers an opportunity to know what they were thinking about as well as allowing them to be corrected by the researchers if there is something that they might have misunderstood. This also allowed for the researchers to understand the reasoning behind the participant choices when performing the emotions and motivation assessments. For convenience the Self Assessment Manikin and the Intrinsic Motivation Inventory were hosted on Google Forms [34], which is an online form host. This allowed for an easier migration of the data into tables as well as providing a more visually pleasant experience to the participants and minimizing the effect of external factors on the participants' emotions.

2) *Self Assessment Manikin (SAM)*:: SAM is a non-verbal assessment, which aims to measure three key emotions that a person could feel as a reaction to using an object [35]. These three different kinds of feelings are as follows: Happy vs. Unhappy, Excited vs. Calm, and Controlled vs. In-control.

SAM is shown in Figure 2. The first row that starts from a happy face and ends at a sad face represents valence. The second row represents the arousal of emotion, ranging

from excited, anxious, explosive to completely relaxed, calm, sluggish, dull, unaroused. The third row represents dominance, by starting from a small figure representing ‘being controlled’ to a large and dominant figure representing ‘being in-control’.

By conducting SAM after the task with the competence sheet and after the task with the web-based competence platform, we aim to find out how developers’ and managers’ emotions are affected by partial automation of competency evaluation. While conducting SAM to the participants (i.e., developers and managers), the researchers used a protocol consisting of a text including what the researchers should say to the participants in order to minimize their influence on the participant and treat each participant similarly in order to circumvent negative effects of threats to internal validity. the SAM protocol containing the text has been adapted from the technical manual of Internal Affective Picture System (IAPS) [36] and it can be found in Appendix F. On SAM, which is shown in Figure 2, the participant can select any of the 5 figures comprising each scale and or between any two figures. As it is shown in Figure 2, this results in a 9 point scale for each dimension.

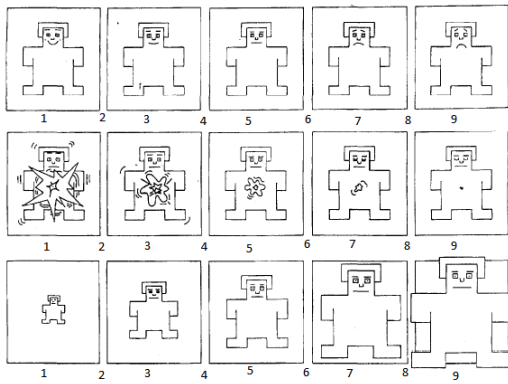


Fig. 2. Self-Assessment Manikin [35]

3) *Intrinsic Motivation Inventory (IMI)*: IMI assesses the participant’s ‘interest/enjoyment’, ‘perceived competence’, ‘effort’, ‘value/usefulness’, ‘felt pressure and tension’, and ‘perceived choice’, while performing a given activity, thus yielding six sub scale scores [31]. Each sub scale consists of 5-7 items (statements) and each item can be rated on a scale from 1-7, 1, 4 and 7 corresponding to “not at all true”, “somewhat true” and “very true”, respectively. We conducted IMI to managers and developers after the task with competence sheet and also after the task with web-based competency platform. We combined the results we obtained with the SAM results and qualitative data obtained from think aloud protocols in order to answer RQ1.2.

While preparing our IMI survey, we selected the following sub scale items that were relevant to our user study from the whole inventory: ‘Interest/Enjoyment’, ‘Perceived Competence’, ‘Pressure/Tension’ and ‘Value/Usefulness’. The IMI statements can be found inside the user study protocol in Appendix F.

4) *Follow-up questions*: The user studies were followed by some interview questions to investigate participants’ thoughts about the automation of the competency sheet into a web-based platform and their impressions about the web-based platform that was developed by researchers. The interview questions can be found inside the user study protocol in Appendix F.

IV. RESULTS

A. Results for Phase 1: Investigation & Elicitation

The data collection consisted of 8 interview that has three parts. The first part focused on collecting information about the interviewee’s role in the company (i.e., developer or manager). Based on the answers, we found out that among the 8 employees we interviewed, there were two developers, three project managers, one architect and two managers.

While some developers believed that the competence sheet would be beneficial to them as one time user, they all agree that it becomes increasingly difficult to keep track of and update it. This notion is only valid to the developers, however when it comes to managers the sheet becomes less convenient. If the manager would like to view the competence of one employee then the sheet serves him well. However, if the manager made it clear that they would like to compare the results of the employees which is an extremely tense and time wasting process that consists of comparing sheets manually. Therefore, all the people that had been interviewed have agreed that implementing the web platform is the best solution. The transcribed interview data can be found in Appendix E.

1) *View of competence analyses in general*: When the interviewees were asked about their thoughts on the importance of measuring competence in the IT field, almost all of them brought up the importance of having it to have a successfully company. Both managers have had exposure to it in the past and realize that having it in a growing business is important if they want to succeed. They believe that measuring competence is an important tool specially in a IT consulting company because it allows for effective staffing and identification of strengths and weaknesses of the organization as a whole which allows them to take action to improve their weaknesses. Since the project managers and architects perform the same tasks as the developers, they will treated as developers in this case study.

Manager: “I don’t think its about measuring the competence. It’s more to show what we know right know and what we want to know. It’s not measurement that decides your salary or prestige in the company. It’s all about inspiration to improve and evolve. Seeing goals that you can achieve by learning is a really good thing in my opinion”

Developers think of measuring competence as an important tool to themselves, while they are aware that it could be measured differently in different organizations, many of them did not have exposure to it outside of Sigma IT Consulting.

Developer: “I think it is necessary because it allows to developers to identify their weakness in different programming areas and what do they know. It also allows you to know what level you are such as senior or junior and it shows you how much you need to reach the next level. Companies have different ways for measuring competency”

2) *View on competence analysis in Sigma:* The results obtained from the interviews showed a mixed impression on the way competence is measured at Sigma IT Consulting. Regarding the accuracy of the competency sheet, some interviewees commented that in general it is easier to measure technical skills over soft skills. There was a general 50/50 split with people that thought that the information in the sheet are sufficient and accurately reflected their skills or not. Some interviewees believe that data might be biased due to the still the effect of a person's confidence and self-esteem on his/her programming skills.

Manager: “I think that it accurately reflects their competence if you know the person. Because you want to know how confident you are. If you have high self-esteem you tend to grade yourself higher and if you have a lower self-esteem you grade yourself lower. So it is important to be familiar with the person that you view their report. It would be difficult for a third party to use it. It will be better over time when people start getting used to it.”

A developers brought up the previous point. Adding to it the observation that the more experienced you are the more that you are aware of what you don't know.

Developer: “Its very hard to measure. So it's hard to know if it actually measure your competence. Depends on many factors. Less experienced thinks they're more experienced and vice versa.”

Negative feedback from some project managers has been received about the usefulness of the competence sheet to them. Since project managers can only fill it in, they neither have access to the other people's data nor do they have the ability to suggest a modification for the programming languages. Most importantly the skills in the sheet are only tailored to developers. In the sheet, project managers are also asked to fill in their competency levels for programming languages, which they might not be using since they are working with the a few programming languages so knowing about their competence in other programming languages and soft skills is not as useful for them.

Developer: “It's pointed towards developers. It's not valued for project manager. It does not say much

about him as a project manager and is not that impactful.”

Everyone that was interviewed agreed that using an excel sheet was an ineffective way to handle measuring competence over a long period of time. An interviewee pointed out that it would have been no problem if it was a one-time deal to use the excel sheet. However since this sheet needs to be updated quarterly, it is an extremely ineffective way to measure competence. To summarize, there was a demand for the partial automation of the competency excel sheet.

Manager: “I think that's what we need to do for many reasons. The storing, we don't have to care about a lot of excel files. We can add versioning, it could be done in excel but it's easier and more accessible in the web.”

As it is seen in the previous quote, the interviewees had a lot of input on what features will increase the value of the competence platform. Some of the features that were mentioned were having the ability to track your changes over time and the ability to have links that will take you to a webpage, which will help you improve a specific skill further.

Manager: “For consultants it's better for them to update their subjects and track their progress over time. For managers it is important for them to view the strong and weak areas of the organization and also use individual data to view the skills that the project manager need for staffing.”

Using MoSCoW [37], the requirements obtained from the interviews and the competence sheet were presented as follows:

Must:

- **1. Competence Sheet** As a manager: Creating/ Deleting/Updating Profiles and adding skills to them.
- **2. Competence Sheet** As a manager: Creating/ As a manager: Creating/ Deleting/ Updating competence subjects for the developers
- **3. Competence Sheet** As a developer: A way for the developer to fill in their competence.
- **4. Interview** As a manager: View the employees that match a profile.
- **5. Interview** As a manager and a developer: Be able to have an account to log-in to the web-platform.

Should:

- **6. Competence Sheet** As a manager: A report page that show the average competence in each subject.
- **7. Interview** As a developer: A function to learn more about skills that you are not familiar with.

Could:

- **8. Interview** As a manager: Creating/ As a manager: View the progress of an employee over time

Won't:

- **9. Interview** As a developer: A customized learning experience that suggest learning tools depending on the level of the developer

B. Results for Phase 2: Development of Web-based Competency Platform

Using the data obtained from phase 1, the following tasks were extracted as shown in table I:

TABLE I
TASK FOR DEVELOPMENT

Task	Requirement	Part
Create Authentication and login feature.	5	Back-End
Create a Subject model and a controller that allows managers to add subjects.	2, 3	Back-End
Create a Current User model and a controller that allows developers to fill in their competence and have a time stamp for it.	5, 3	Back-End
Create a Survey model and a controller that allows managers to fetch the answers of an employees competence and be able to search by time.	3, 8	Back-End
Create a Profile creator model and a controller that allows managers to create/edit/delete a profile containing specific programming languages.	1,	Back-End
Create a Profile model and a controller that allows developers to view which profiles they match and what subjects they need to improve at in order to match the profile.	7, 9	Back-End
Create a Profile model and a controller that allows a manager to view the names of the employees that match a profile.	4	Back-End
Create a Gap model and a controller that allows managers to view the average value of each individual subject using the data of all the developers.	6	Back-End
Create a login page so different types of users can log in.	5	Front-End
Create a User profile page that displays the profiles that the developer match and doesn't match.	9	Front-End
Create a Competence page where the developer will fill in his/her competence	3	Front-End
Create a Survey page that allows the manager to view the competence values for a user.	8	Front-End
Create a Company gap page for the managers to see the gap in competence.	6	Front-End
Create a Profile Creator page for the managers.	1	Front-End
Create a Profile Manager page for the managers.	1, 4	Front-End

Development went according to plan, the prototype was completed. The sprints that were planned were completed in time and the supervisors has expressed their satisfaction with our work. The screen shots of the features of the application can be seen in detail in Figures 4-14 in Appendix D and consists of two parts, which are the 'developer part' and 'manager part', respectively. A log-in feature allows the developers and managers to access their parts. Features of each part are explained below.

Developer Part:

- 1) Profile: This feature allows the developer to view the profiles added by the manager; such as junior front-end developer as shown in Figure 5. The developer can then access a page for a single profile to view profile's qualifications and how his/her competency level matches with those qualifications as shown in Figure 6.
- 2) My Competence: This feature allows the developer to view and modify their competence values for each subject that the manager has added as shown in Figure 7.

Manager Part:

- 1) Survey answers: This feature allows the manager to view a developer's competence from a previous date as well as developers' most recent competence level as shown in Figure 8.
- 2) Subjects: This feature allows the manager to add/edit/delete subjects shown in Figure 9.
- 3) Manager report: This feature allow managers to view the average competency level in the company for each skill so that developers can view their strongest and weakest subjects as shown in Figure 10.
- 4) Profile Administration: This feature consists of an overview of the profiles such as; Fullstack and the functionality to add or delete a profile as shown in Figure 11 and a detailed view where you can add and/or delete skills from a profile as shown in Figure 12.
- 5) Profile report: This feature consists of an overview of the number of developers who got the required skill to match the profiles such as Fullstack as shown in Figure 14 and a detailed page which shows the names of the users that match the profile viewed as shown in Figure 13.

C. Results for Phase 3: Evaluation

The data collection consisted of three parts. The first part contained the results of the emotions of the participants that was collected with SAM. The second part contained the results of the motivation of the participants that was collected with the IMI assessment. The third part was a short interview, which aimed to obtain information about what managers and developers think about the web-based competency platform. Each developer was given an ID that starts with "user" and then a number. The same was done for the manager except that the ID starts with "manger" followed by a number. In our analysis, we also added data we obtained from user10, who was the participant of our pilot user studies, since no modifications were made to the content of the study after the pilot.

1) *SAM Results:* Table II displays the results of how using the web-platform/sheet made them happy/unhappy. In the range 1-9, a value of 5 represents feeling indifferent. If the value is higher than 5 then the participant feels unhappy. On the other hand, if the value is less than 5 then the participant is happy.

TABLE II
SAM RESULTS FOR VERY HAPPY VS. VERY UNHAPPY
VALUES RANGE FROM 1-9 (9 IS VERY UNHAPPY AND 1 IS HAPPY)

ID	Sheet	Website	First to be shown
user1	5	4	sheet
user2	8	4	website
user3	7	3	sheet
user4	4	2	sheet
user5	5	3	website
user6	4	3	sheet
user10 (Pilot)	5	1	sheet
manager1	3	2	sheet
manager2	3	1	website

Table II shows lower values when using the web-platform, thus showing that the developers and the managers are happier when using the site. Using all the data in Table II, the average value for happiness/unhappiness while using the website is 2.5, the average for value while using the sheet is 4.9. This shows that the general effect of the web-platform on the emotions is increased happiness.

“I like the accessibility that is provided Having the ability to use make changes in real time without having to exchange emails is really ”

TABLE III
SAM RESULTS FOR VERY HAPPY VS. VERY UNHAPPY
AVERAGE VALUES DEPENDING ON THE ORDER

First to be shown	Average Sheet	Average Website
Sheet	4.7	2.5
Website	5.3	2.7
Overall Average	4.9	2.5

Table III displays the average values depending on the order of presentation. The value of happiness for the website is lower when presented with the sheet first, mean the participants were happier.

Table IV displays the results of how using the web-platform/sheet made the developers and managers excited/calm. The higher the number the more calm the participant, 9 is very calm. The lower the number the more excited the participant, 1 is very excited.

TABLE IV
SAM RESULTS FOR CALM VS. EXCITED
VALUES RANGE FROM 1-9 (9 IS CALM AND 1 IS EXCITED)

ID	Sheet	Website	First to be shown
user1	7	3	sheet
user2	8	6	website
user3	7	5	sheet
user4	6	1	sheet
user5	7	4	website
user6	7	8	sheet
user10 (Pilot)	6	3	sheet
manager1	2	2	sheet
manager2	8	8	website

Table IV shows lower values when using the web-platform, thus showing that the developers and managers are more

excited when using the site. Using all the data in Table IV, the average value for excitement/calmness while using the website is 4.4, the average for value while using the sheet is 6.4. Which shows that that on average the developers and managers are more excited when using the website.

“I am excited by how easy it is to update my competence in comparison to the sheet ”

TABLE V
SAM RESULTS FOR EXCITED VS. CALM
AVERAGE VALUES DEPENDING ON THE ORDER

First to be shown	Average Sheet	Average Website
Sheet	5.8	3.6
Website	8	6
Overall Average	6.4	4.4

Table V displays the average values depending on the order of presentation. The value of excitement/calmness for the website is lower when presented with the sheet first, meaning the participants were more excited.

Table VI displays the results of how using the web-platform/sheet made them feel controlled/in-control. The higher the number the more in-control the participant, 9 is in-control. The lower the number the more controlled the participant, 1 is controlled.

TABLE VI
SAM RESULTS FOR CONTROLLED VS. IN-CONTROL
VALUES RANGE FROM 1-9 (9 IS CONTROLLED AND 1 IS IN-CONTROL)

ID	Sheet	Website	First to be shown
user1	4	7	sheet
user2	5	8	website
user3	3	6	sheet
user4	3	2	sheet
user5	4	8	website
user6	9	8	sheet
user10 (Pilot)	7	8	sheet
manager1	3	3	sheet
manager2	9	9	website

Table VI shows higher values when using the web-platform, thus showing that the developers and the managers feel more in-control when using the site. Using all the data in Table VI, the average value for controlled/in-control while using the website is 6.5, the average for value while using the sheet is 5.2, which shows that on average the developers and managers feel slightly more in control when using the website.

“The ability to update my sheet in real-time makes me feel like I am more in-control over my competence and I can update it whenever I want”

TABLE VII
SAM RESULTS FOR CONTROLLED VS. IN-CONTROL
AVERAGE VALUES DEPENDING ON THE ORDER

First to be shown	Average Sheet	Average Website
Sheet	4.8	5.6
Website	6	8.3
Overall Average	5.2	6.5

Table VII displays the average values depending on the order of presentation of the sheet and web-based platform. The value of feeling controlled/in-control for the website is lower when presented with the sheet first, meaning the participants feel less in-control.

2) *IMI Results:* As mentioned previously, for this study researchers selected four sub scales, which were ‘Interest/Enjoyment’, ‘Perceived Competence’, ‘Pressure/Tension’ and ‘Value/Usefulness’, respectively. For each sub scale 4 to 9 items (statements) were selected. The results for each sub scale were calculated by taking the average of the scores in the range 1-7 the participants assigned to the items. The ‘Interest/Enjoyment’ sub scale measures the extent to which the performed tasks were interesting and enjoyable. The values range from one to seven, a higher value when using the web-platform is more desirable for the this sub scale, since it show that the web-platform has a positive effect on the motivation of the developers/managers.

TABLE VIII
IMI RESULTS FOR INTEREST/ENJOYMENT
VALUES RANGE FROM 1-7(HIGHER IS BETTER)

ID	Sheet	Website	First to be shown
user1	4	5.5	sheet
user2	1.75	5.5	website
user3	2.5	5.25	sheet
user4	4	7	sheet
user5	3.5	5.75	website
user6	2.25	4	sheet
user10 (Pilot)	2	6.5	sheet
manager1	6.75	6.25	sheet
manager2	5	6.75	website

Table VIII shows higher values when using the web-platform, thus showing that the developers and the managers feel more enjoyment/interest when using the site. Using all the data in table VIII, the average value for enjoyment/interest while using the website is 5.8, the average for value while using the sheet is 3.5. Which shows that that on average the developers and managers are more enjoyment/interest when using the website.

“I like that I can learn more in the areas that I am not familiar with, this gives more reasons to go back and update my sheet”

The second sub scale that was examined was the perceived competence, which sub scale evaluates how the developers/managers perceived their ability to perform the given task by judging their skill. The values range from one to seven, a

higher value when using the web-platform is more desirable for the this sub scale, since it shows that the web-platform is easier to use.

TABLE IX
IMI RESULTS FOR PERCEIVED COMPETENCE
VALUES RANGE FROM 1-7(HIGHER IS BETTER)

ID	Sheet	Website	First to be shown
user1	4	5.5	sheet
user2	4	6.5	website
user3	6	6	sheet
user4	5.5	7	sheet
user5	5.5	6	website
user6	7	6.5	sheet
user10 (Pilot)	4.5	5.5	sheet
manager1	6	6	sheet
manager2	4	7	website

Table IX shows higher values when using the web-platform, thus showing that the developers and the managers feel more competent when using the site. Using all the data in Table IX, the average value for competent while using the website is 6.2, the average for value while using the sheet is 5.1. Which shows that that on average the developers and managers are more competent when using the website.

“I think that filling in a sheet is easy, so there is no difference between the website and the sheet in that area. But I think that the website is more convenient since I don’t need to search for an email and I don’t need to remember the file location”

The third sub scale that was examined was the effort/importance. This areas evaluates how much effort the developers/managers spent on the task and their perceived importance of the task. The values range from zero to seven, a higher value is more desirable for the this sub scale. The values obtained from the sheet and web-platform should be similar seeing as the main goal of the web-platform should be the same as the sheet.

TABLE X
IMI RESULTS FOR EFFORT/IMPORTANCE
VALUES RANGE FROM 1-7(HIGHER IS BETTER)

ID	Sheet	Website	First to be shown
user1	3.25	4.5	sheet
user2	4	5	website
user3	3.5	4.5	sheet
user4	6	5.75	sheet
user5	5	5.25	website
user6	3.75	3.75	sheet
user10 (Pilot)	3.5	4.25	sheet
manager1	5.5	4.25	sheet
manager2	6.5	4.75	website

Table X shows higher values when using the web-platform, thus showing that the developers and the managers put more effort into and feel that the task is more important when using the site. Using all the data in table X, the average value for competent while using the website is 4.7, the average for value

while using the sheet is 4.6. Which shows that that on average the developers and managers put slightly more effort and view the task as slightly more important when using the website.

“Filling in my competence is important so it doesn’t matter if I do it online or on the sheet. I spend the same effort thinking about the values of my competence, but I think that sending the sheet as an email attachment makes the sheet takes a little bit more effort.”

The fourth sub scale that was examined was the pressure/tension. This sub scale evaluates how the developers/managers viewed the pressure and tension inflicted from doing the task. The values range from zero to seven, a lower value when using the web-platform is more desirable for the this sub scale, since it show that the web-platform is not stressful to use.

TABLE XI
IMI RESULTS FOR PRESSURE/TENSION
VALUES RANGE FROM 1-7(LOWER IS BETTER)

ID	Sheet	Website	First to be shown
user1	3.6	3	sheet
user2	3	3	website
user3	2.8	2.4	sheet
user4	3.6	4.2	sheet
user5	2	1.4	website
user6	2	2.2	sheet
user10 (Pilot)	4.4	3.4	sheet
manager1	2.4	2.2	sheet
manager2	2.2	2.2	website

Table XI shows lower values when using the web-platform, thus showing that the developers and the managers feel less anxious using the site. Using all the data in table XI, the average value for competent while using the website is 2.7, the average for value while using the sheet is 2.9. Which shows that that on average the developers and managers feel slightly less anxious when using the website.

“There is always external stress from other projects and deadlines that makes me feel anxious when filling in the sheet”

The fifth sub scale that was examined was the value/usefulness. This sub scale evaluates how the developers/managers viewed the usefulness of the task the task. The values range from zero to seven, a higher value when using the web-platform is more desirable for the this sub scale, since it show that the web-platform is useful.

TABLE XII
IMI RESULTS FOR VALUE/USEFULNESS
VALUES RANGE FROM 1-7(HIGHER IS BETTER)

ID	Sheet	Website	First to be shown
user1	4.6	5.6	sheet
user2	4.2	6	website
user3	5.8	6.2	sheet
user4	6.8	7	sheet
user5	4.4	5.6	website
user6	5	5.4	sheet
user10 (Pilot)	4.8	6.2	sheet
manager1	6.6	6.8	sheet
manager2	6.4	7	website

Table XII shows higher values when using the web-platform, thus showing that the developers and the managers view the website as more useful/valuable tool when doing their tasks. Using all the data in table XII, the average value for competent while using the website is 6.8, the average for value while using the sheet is 5.4. Which shows that that on average the developers and managers view the website as more useful/valuable.

“I like how I don’t need to email my manager when I update my competence, I can go to the website when I want and I update it and I can also learn more about a programming language if I want”

3) *Interview data:* There were three main areas that were examined in this part by asking 2 questions to all the developers/managers and one additional question to the ones that helped create the sheet. The entire transcript for the interviews can be found in Appendix G.

- 1) (To the creator)Does the web based system perform as expected in practice?
- 2) What do you think about of the keeping track of and updating the web-based competence system?
- 3) What are your thoughts about turning the competence sheet into a web-based system?

The first question was directed towards the employees that helped create the sheet, the responses that were obtained from this question state that the web-based system does indeed perform as expected.

“Yes I think so. However, it has some potential for improvement.”

The second question was directed towards both the developers and the managers. The aim of the question was to examine how effectively can the web-platform help the developers keep track of and update their competence

“ I think it was good. Better and easier than before. More accessible in comparison to the sheet.”

The third question was also directed towards both the developers and the managers. The question aims at validating

if the decision of creating a web-platform. All the employees that were interviewed thought that the decision to make the web-platform was good and it's overall a more pleasant and effective experience to update competence and keep track of it.

“It's a good and solid way to go. The profile and learn more functionality makes it awesome. There's no limitations to this so more functionality can easily be added.”

It is also important to note that the managers argue that the excel sheet is an excellent tool in the short-run. However, they do believe that the web-platform should be the way to go since it supports an expanding company.

V. DISCUSSION

In this section the researchers answer the research questions in detail by discussing the results and comparing it to the existing literature. However, it is important to note that there are very few studies in regards to competence evaluation in IT and most of them are only tangential to the research conducted in this case study. The researchers also aim to discuss the case-specific results as well as results that are related to companies other than Sigma IT Consulting. To finalize the researchers also discuss which findings could contribute to future studies of competency evaluation in the IT field.

A. RQ 1.1 How does Sigma's evaluation of technical competence within software engineering compare to the approaches for evaluating competence in the literature?

One theme that is clear from the results is that competence evaluation at Sigma is there to motivate the employees in regards to learning more and improving within the field. One of the managers argues that:

“I don't think its about measuring the competence. It's more to show what we know right know and what we want to know. It's not measurement that decides your salary or prestige in the company. It's all about inspiration to improve and evolve. Seeing goals that you can achieve by learning is a really good thing in my opinion”

The developers share the same view and rarely view the competence evaluation as a test of their ability or a matter of prestige. They see it as an opportunity to progress and become better within the field. This differs from the majority of the literature which mainly argues that competence evaluation is done to ensure quick delivery of software [10] and/or the ability to measure the employees ability to program or solve abstract problems [14] [16].

It is important to note that while not being the main goal Sigma still use the competence evaluation to measure competence to determine how to assign their consultants to ensure effectiveness. This is argued by one of the developers:

“For managers it is important for them to view the strong and weak areas of the organization and also use individual data to view the skills that the project manager need for staffing.”

This is closer to what the literature argues “the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technology” [12].

B. RQ 1.2 How does partial automation of the competence evaluation platform affect emotions and motivations of developers and managers?

By conducting SAM and IMI assessments, the researchers were able to verify that the web-platform had a positive impact on the emotions and motivation of the employees at Sigma IT Consulting. When comparing the values of the developers to the managers in the results section, it is clear that the developers experience greater increase in positive emotions such as happiness, excitements and control than the managers(. The motivation for the web-based competence platform of the developers is also slightly higher than the managers. One of the possible reasons for managers having lower motivation could be that the old excel competence sheet was introduced a year ago and the managers stated that the sheet was a passable short term solution. However, they managers also stated that in the long-run, the negatives of the sheet outweigh the positives which would results in an even greater increase positive increase in the SAM and IMI results.

The order of exposure had an interesting effect on the ratings that the user study participants made. When the users were presented with with the sheet before the web-platform, the values that were given to the effect of the emotions tended to be higher than if the order was the inverse. An inverse relationship can be observed, where the sheet had more positive emotions when presented first.

Table III contains average values depending on the order of presentation for sheet and the web-platform.

The findings in table III conforms to the previously stated observation in regards to the inverse relationship of the emotions by showing the happiness/unhappiness values depending on the order shown. The values for the sheet are higher if presented first with the web-platform, meaning that the participants were unhappier. The table also shows that the participants were happier with the website if they were first presented with the sheet, lower value means happier. The same relationship can be examined in the excitement/calmness data shown in table V.

Table VII displays the value of control that the participant has so a higher value is more desirable. However, this table does not follow the previously mention observations. One of the reasons for the influence on the data could be that due to the similarity in how data input is on the sheet and the website. The developers felt more confident filling in the sheet after using the website, which would explain the rise from 4.8 to 6.

However, the participants felt more in control when using the site first; this could be due to the fact that they remember the website giving them less control in the past so their memory tends to be worst than it actually is, this leads to a higher control level for the website.

Overall, there is a positive impact of using a web-platform on the emotions of the employees at Sigma IT Consulting.

Overall, the web-platform had a positive effect on the motivation of the employees. According to the results, having a website increased the enjoyment of filling the website because it is no longer a tedious task that requires constant back and forth mailing between the managers and the developers. The results also shows that, having data that can be edited in real time and having the manager be able to view it as soon as it is updated means less pressure and increased usefulness of the tool. Another factor supported by the results observed that affects the usefulness is the learn more feature that allows the developers to explore technical and soft skills that they are not familiar with.

As observed in the results, the importance and effort of the tasks gives a similar value on both the web-platform and the sheet because the tasks is of equal importance no matter where it is done. The effort taken to input the values should remain similar in both the sheet and the web-platform.

Developers and managers alike commented on the improved accessibility and modifiability of their competence which is the main reason for the overall increase in their motivation as a result of partially automating the competence sheet.

VI. THREATS TO VALIDITY

A. Internal Validity

One of the major concerns when it came to internal validity was the influence of being exposed to the competence sheet first followed by the web-platform. This could cause a mere-exposure effect as argued by Bornstein and D'agostino [32] having the interviewee alter their answers depending on the order of exposure. To address this issue half of the interviewers were shown the sheet first and the second half were shown the web-platform first. Another internal validity is the low sample size of employees available for the study, due to the limited free time that the developers and managers data could only be collected from 8 people over the span of two days on two separate occasions for phase one and three.. By having a larger number of employees participate in the study to provide a more extensive data set would assist in identifying potential answers to our research questions. However, for this study a set number of 9 were available for the researchers to interview, and to conduct SAM and IMI. It took researchers too much effort to convince the developers and managers to take part in this research, since during the period we conducted this research study, most employees were quite busy. However, in order to circumvent the problem of small number of participants, we complemented the quantitative data we obtained from SAM and IMI results with qualitative data obtained from interviews and think aloud sessions.

B. External Validity

The main external validity threat were our study being for a specific software within a specific scope. By designing something that would only be used inside Sigma IT Consulting and not using it to study the effects in other companies. This was a known external validity from the beginning seeing as the prototype is based on the competence sheet that was already in use at Sigma IT Consulting. In order to overcome this validity threat using it with different teams within the other departments inside Sigma.

C. Construct Validity

While conducting the interviews and questionnaires having a realistic setting in order to ensure that the answers actually reflect what the interviewee would feel when conducting the tasks in reality. In order to ensure this the researchers simulated a setting where the interviewee would be asked to conduct the tasks in the same procedure with some limitations due to time constraints.

VII. CONCLUSION

To sum up, the research aimed at exploring and evaluating the way competence is measured in IT. This case study aims at answering the research question presented in this paper, as well as it's two sub-research questions. We addressed the main research question by dividing it into two sub research questions.

We addressed our first sub research question **RQ 1.1“How does Sigma’s evaluation of technical competence within software engineering compare to approaches for evaluating technical competence from the literature?”** by having interviews before and after the implementation of the web-platform. These interviews were conducted to gather information how and why competence evaluation is done at Sigma IT Consulting. The data was then compared to the literature to see if Sigma IT Consulting’s approach differed.

The second sub research question **RQ 1.2“How does partial automation of the competence evaluation platform affect emotions and motivations of developers and managers?”** was addressed by partially automating the competence sheet into a web-platform. After the implementation, an evaluation in form of user studies were conducted for the competence sheet and the new competence web-platform. This helped the researchers gather information about the motivation and emotions of the employees. The data was compared in order to evaluate the effect on emotions, motivation and general advantages/disadvantages of partially automating the competence evaluation. The data shows that the web-platform has a positive impact on the emotions and motivation of the employees, and no disadvantages were identified.

VIII. FUTURE WORK

Due to the constraint of not being able to show the system to other consultant companies. The only way to continue with this study is to conduct the interviews and user studies with more employees within sigma, due to the fact that this study engaged

with a single team. More SAM and IMI assessments must take place in order to increase the validity to the statistical data.

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APPENDIX A
INTERVIEW QUESTIONS

A. Part 1:

- 1) What is your position in this firm?
- 2) For how long have you been working here?
- 3) How long have you been working in the field? How would you summarize your experience? In terms of working experience.
- 4) What is your involvement with the competency sheet? (did you use it? Did you help create it?)
 - a) Is your competency evaluated?
 - b) Did have a role in creating?
 - c) Do you use it to assign people to the projects?

B. Part 2:

- 1) What is your general impression of measuring competence in software engineering?

C. Part 3:

- 1) How do you feel about the way competency is measured in this company?
- 2) Do you think it accurately reflects your competence?
 - a) Does the competence sheet effectively measure your ability to solve abstract problems?
- 3) (If creator) Does the competency sheet perform as expected in practice?
- 4) (The assigner of tasks) Has the assignment of the tasks been successful?
- 5) What do you think of the current way of keeping track of and updating the competence sheet?
- 6) What are your thoughts about turning the competence sheet into a web-based system?
- 7) Are there any special features that you would like to have if the web-platform is to be implemented?

APPENDIX B
SYSTEM ARCHITECTURE

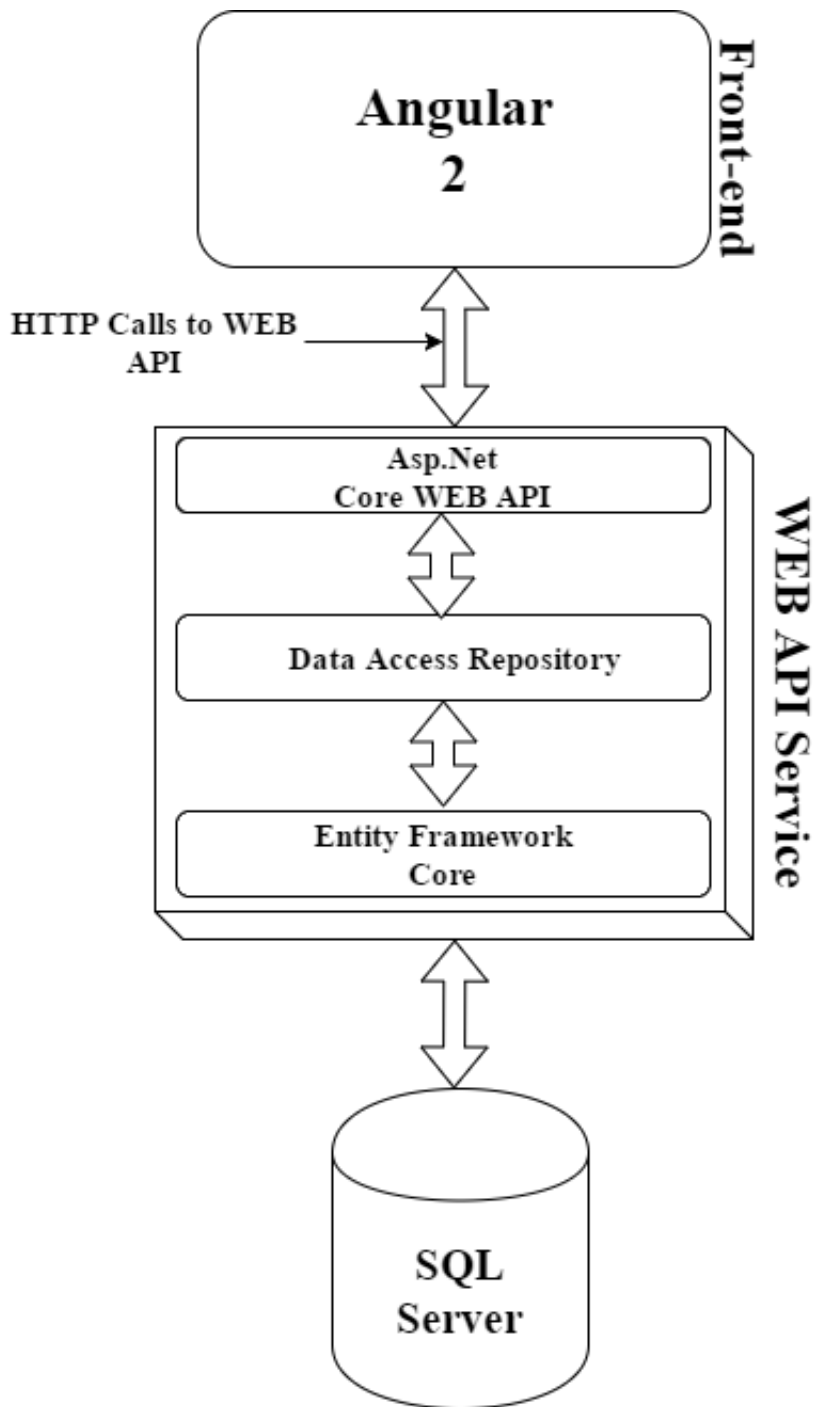


Fig. 3. System Architecture

APPENDIX C
PILOT INTERVIEW DATA

A. Part 1:

- 1) What is your position in this firm?
 - System developer / talent scout.
- 2) For how long have you been working here?
 - 2 years as a developer, 0,5 years as a talent scout
- 3) How long have you been working in the field? How would you summarize your experience? In terms of working experience.
 - First job.
- 4) What is your involvement with the competency sheet? (did you use it? Did you help create it?)
 - Just filling it in

B. Part 2:

- 1) What is your general impression of measuring competence in software engineering?
 - Tough to measure. Sees the need. Larger organizations need it more. Matching people to a task.

C. Part 3:

- 1) How do you feel about the way competency is measured in this company?
 - Has Not been measured until now. Doesn't know how it compares to other companies. Picking your own levels is good.
- 2) Do you think it accurately reflects your competence?
 - Very black and white. Hard to answer. Haven't given much thought to it however he thinks it reflects his knowledge. Some stuff he knows is not on the list. More than 5 levels could be good. Hard to pinpoint because knowledge is personal.
- 3) What do you think of the current way of keeping track of and updating the competence sheet?
 - Lost his sheet twice. Destroyed excel rows accidentally. Too manual. Very new so still learning how to use it.
- 4) What are your thoughts about turning the competence sheet into a web-based system?
 - Very good. Hoping its gonna be easier to fill in and for managers to see results.
- 5) Are there any special features that you would like to have if the web-platform is to be implemented?
 - The ability to read up on languages and improve your current level of skills.

APPENDIX D

PHASE 2 SCREEN SHOTS

Sigma Competence Platform

Username:

Password:


 Log in




Fig. 4. Login Page

Sigma Competence Platform

[Profile](#)

[My Competence](#)

 Log out


Profile Name	Category	Profile Matched	
Front-End Junior	Front-End	Not Fulfilled!	View Profile
Fullstack Junior	Fullstack	Not Fulfilled!	View Profile

Fig. 5. Profile Overview

Sigma Competence Platform

[Profile](#)

[My Competence](#)

 Log out

Front-End JuniorFront-End			
Skill	My Level	Level Required	
Frontend Framework (tex Bootstrap)	4	3	
HTML	4	3	
CSS	3	3	
Javascript	0	3	Learn More!
Go back			

Fig. 6. Profile Detailed

Sigma Competence Platform

[Profile](#)

[My Competence](#)

Log out

Subject Name	Level	Link	Category
Apache HTTP Server	3	Learn More!	Hosting
ASP.NET Core MVC	2	Learn More!	Programming
ASP.NET Core WebApi	1	Learn More!	Programming
ASP.NET MVC	5	Learn More!	Programming
ASP.NET WebApi	0	Learn More!	Programming
ASP.NET WebForms	0	Learn More!	Programming
Automatiserad deployment	0	Learn More!	Tool
Azure App Services	0	Learn More!	Hosting
Azure Networking	0	Learn More!	Network
Azure Search	0	Learn More!	Tool
Azure Service Bus	0	Learn More!	Programming
Bash	0	Learn More!	Programming
BDD	0	Learn More!	Soft skill
C#	0	Learn More!	Programming

Fig. 7. My Competence

Sigma Competence Platform

[Survey Answers](#)

[Subjects](#)

[Manager Report](#)

[Profile Administration](#)

[Profile Report](#)

Log out

User Name	Last Entry	Subject Name	Level
user1	2017-05-18T09:40:07.0942529+02:00	Swift	3
user1	2017-05-18T09:40:33.6134799+02:00	NoSql	5
user1	2017-05-18T09:40:26.770398+02:00	Java	3
user1	2017-05-18T09:39:56.6561138+02:00	EPiServer	3
user1	2017-05-18T09:40:16.2300444+02:00	Xamarin	2

User Name:

user1

Date:

Search

Fig. 8. Survey Answers

WinForms	msdn.microsoft.com/en-us/library/dd30h2yb(v=vs.110).aspx	Programming	X
WordPress	codex.wordpress.org/Developer_Documentation	Web	X
WPF	msdn.microsoft.com/en-us/library/ms754130(v=vs.110).aspx	Programming	X
Xamarin	developer.xamarin.com/guides/android/getting_started/hello_android/	Mobile	X
XCode	codewithchris.com/xcode-tutorial/	Programming	X
Subject Name			
<input type="text"/>			
Link			
<input type="text"/>			
Category			
<input type="text"/>			
<input type="button" value="Submit"/>			

Fig. 9. Subjects

Sigma Competence Platform						
Survey Answers Subjects Manager Report Profile Administration Profile Report <input type="button" value="Log out"/>						
Subject Name	Level 1 Count	Level 2 Count	Level 3 Count	Level 4 Count	Level 5 Count	Average value
Git	0	0	0	0	1	5
HTML	0	0	0	1	1	4.5
ASP.NET Core WebApi	0	0	0	1	0	4
C#	0	0	1	0	1	4
Facebook API	0	0	0	1	0	4
Frontend Framework (text Bootstrap)	0	0	0	1	0	4
MySQL	0	0	0	1	0	4
PHP	0	0	0	1	0	4
REST	0	0	0	2	0	4
NoSql	0	1	0	0	1	3.5

Fig. 10. Manager Report

Sigma Competence Platform

[Survey Answers](#)
[Subjects](#)
[Manager Report](#)
[Profile Administration](#)
[Profile Report](#)

Log out

Profile Name	Category		
Front-End Junior	Front-End	View Profile	Delete Profile
Fullstack Junior	Fullstack	View Profile	Delete Profile

Profile Name:

Fullstack Senior

Category:

Fullstack

Create Profile

Fig. 11. Profile Administration Overview

Sigma Competence Platform

[Survey Answers](#)
[Subjects](#)
[Manager Report](#)
[Profile Administration](#)
[Profile Report](#)

Log out

Front-End Junior
Front-End

Skill Name	Level	
Frontend Framework (tex Bootstrap)	3	Delete this Skill
HTML	3	Delete this Skill
CSS	3	Delete this Skill
Javascript	3	Delete this Skill

Subject Name:

Apache HTTP Server

Subject Level:

1

Submit Subject

Go back

Fig. 12. Profile Administration Detailed

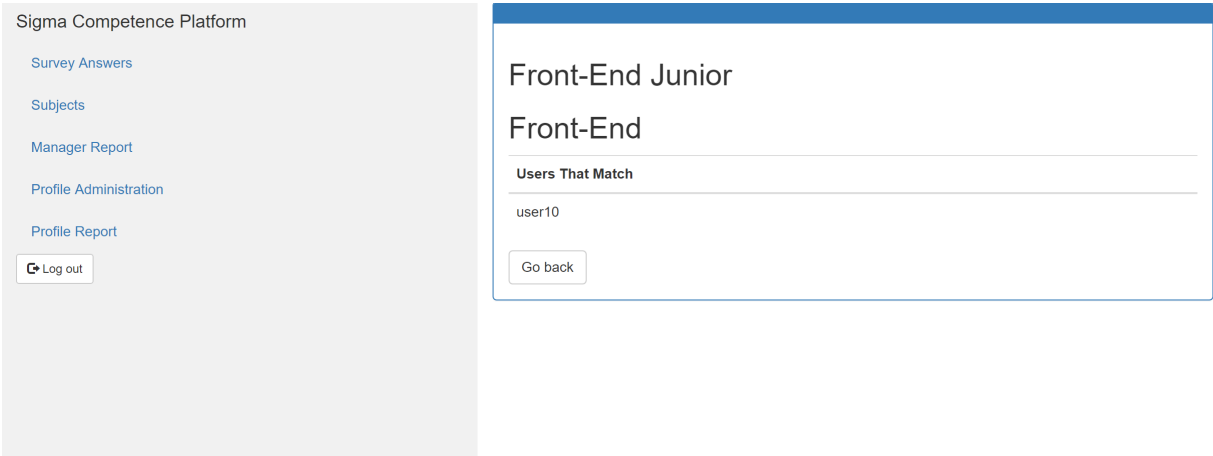


Fig. 13. Profile Report Detailed

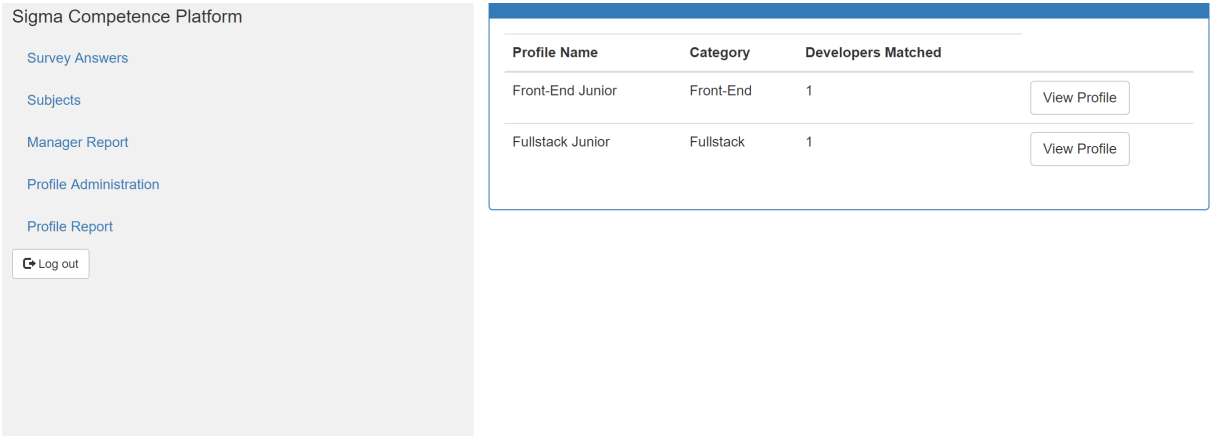


Fig. 14. Profile Report Overview

APPENDIX E
INTERVIEW DATA

A. Interview 1

- 1) **What is your position in this firm?**
- Project Manager.
- 2) **For how long have you been working here?**
- Two and a half years.
- 3) **How long have you been working in the field? How would you summarize your experience? In terms of working experience.**
- Six years. Started working as a developer for a year and then moved on to project management. A mixture of many areas but the main trend is project management.
- 4) **What is your involvement with the competency sheet? (did you use it? Did you help create it?)**
- I am a user of the competence sheet, I fill it out.
- 5) **What is your general impression of measuring competence in software engineering?**
- I think it is necessary because it allows developers to identify their weaknesses in different programming areas and show their strengths. It also allows you to know what level you are such as senior or junior and it shows what competence you need to reach the next level. Companies have different ways for measuring competency in my experience.
- 6) **How do you feel about the way competency is measured in this company?**
- I haven't had my competence measured in other companies. This is the first time I experience this.
- 7) **Do you think it accurately reflects your competence?**
- I think the 1-5 scale is a good way of showing your competence. It could be described more clearly though.
 - a) **Does the competence sheet effectively measure your ability to solve abstract problems?**
- No, the sheet doesn't help identify your ability to solve abstract problems.
- 8) **What do you think of the current way of keeping track of and updating the competence sheet?**
- I don't really like it because you need to keep exchange e-mails and there are a lot of them to keep track of. I'm not a fan of it in general.
- 9) **What are your thoughts about turning the competence sheet into a web-based system?**
I think that would be the best way to handle it.
- 10) **Are there any special features that you would like to have if the web-platform is to be implemented?**
- To be able to compare your progress and see how you have improved over time. Also the ability to contact the administrators in regards to the subjects of the sheet. If the current data is wrong or outdated the admins should be made aware.

B. Interview 2

- 1) **What is your position in this firm?**
- Manager

- 2) **For how long have you been working here?**
- Since 2005, but I also worked here 1999 to 2002
- 3) **How long have you been working in the field? How would you summarize your experience? In terms of working experience.**
- Since 1994. I started as a developer and worked as a developer until 2010 and then went to project management
- 4) **What is your involvement with the competency sheet? (did you use it? Did you help create it?)**
- I made it. I use it to assign people roles and do an inventory of all of the employees and their competence. It has not been used much since we are not many people so you are familiar with the developers and their skill level. We are expanding so we need to document competence better.
- 5) **What is your general impression of measuring competence in software engineering?**
- I have not done it outside of sigma, but it is important to measure competence. It is especially important for people with a similar position as me since it allows us to find out which developer is right for which position.
- 6) **How do you feel about the way competency is measured in this company?**
- We have developed it last year and we used it ones and it worked that time, but we realized that we needed traceability.
- 7) **Does the competency sheet perform as expected in practice?**
- I think that it accurately reflects their competence if you know the person. Because you want to know how confident you are. If you have high self-esteem you tend to grade yourself higher and if you have a lower self-esteem you grade yourself lower. So it is important to be familiar with the person that you view their report. It would be difficult for a third party to use it. It will be better over time when people start getting used to it.
- 8) **What do you think of the current way of keeping track of and updating the competence sheet?**
- It's not good. Me and the other manager have our versions stored and there is no synchronization between our versions.
- 9) **What are your thoughts about turning the competence sheet into a web-based system?**
- I think that's what we need to do for many reasons. The storing, we don't have to care about a lot of excel files. We can add versioning, it could be done in excel but it's easier and more accessible in the web.
- 10) **Are there any special features that you would like to have if the web-platform is to be implemented?**
- For consultants it's better for them to update their subjects and track their progress over time. For managers it is important for them to view the strong and weak areas of the organization and also use individual data to view the skills that the project manager need for staffing.

C. Interview 3

- 1) **What is your position in this firm?**
- Software Architect.
- 2) **For how long have you been working here?**
- 1 and a half year.
- 3) **How long have you been working in the field? How would you summarize your experience? In terms of working experience.**
- 13 years give or take. Pretty extensive experience.
- 4) **What is your involvement with the competency sheet? (did you use it? Did you help create it?)**
- I was part of deciding what should be in the actual sheet. Creating of the profiles(frontend/bakend) etc. Also fills in the sheet. Does not look at the results however can see the results if he wants.
- 5) **What is your general impression of measuring competence in software engineering?**
- The reason why people do it is because it is useful to start projects and find available resources and skillsets. What do I know and what do I want to know more about. Have dealt with it in some form at other companies as well. Some kind of sheet or matrix is the most common solution I think.
- 6) **How do you feel about the way competency is measured in this company?**
- Don't really like it at all at the moment. It feels tacky to send around excel files.
- 7) **Do you think it accurately reflects your competence?**
- Its very hard to measure. So it's hard to know if it actually measure your competence. Depends on many factors. Less experienced thinks they're more experienced and vice versa.
 - a) **Does the competence sheet effectively measure your ability to solve abstract problems?** - No.
- 8) **Does the competency sheet perform as expected in practice?**
- I don't really know because I didn't have any expectations. Have been used a bit but we haven't talked to much. Managers mostly use it.
- 9) **What do you think of the current way of keeping track of and updating the competence sheet?**
- We haven't really been able to update it. I can see a lot of problems with updating it in its current form. I don't even know where my current file is. I have no idea who's keeping track of it. If I wanna fill it in again I need a new file etc.
- 10) **What are your thoughts about turning the competence sheet into a web-based system?**
- It feels way better because you don't have to do the manual steps anymore. You can do it whenever you want to without fixed times. If i complete a project I can update it depending on the stuff i learned.
- 11) **Are there any special features that you would like to have if the web-platform is to be implemented?**
- Not really any special features. Learning more about

the subjects. More explanations of them. If you don't know the acronym you cant really answer the question.

D. Interview 4

- 1) **What is your position in this firm?**
- Developer
- 2) **For how long have you been working here?**
- Since October 2013.
- 3) **How long have you been working in the field? How would you summarize your experience? In terms of working experience.**
- This is my first job within the field.
- 4) **What is your involvement with the competency sheet? (did you use it? Did you help create it?)**
- I just fill it out for my quarterly meeting with my manager.
- 5) **What is your general impression of measuring competence in software engineering?**
- Not really. The only thing I have done before is fill out a stack overflow form, a yearly online survey and read some reports. Does not really have any impression about it.
- 6) **How do you feel about the way competency is measured in this company?**
- The competence matrix is very new. We haven't done much measuring yet and maybe it could've been more focused on the techniques and frameworks for more specific positions. I'm working with back-end so I dont really need to answer the front-end questions.
- 7) **Do you think it accurately reflects your competence?**
- Yes I think it does.
 - a) **Does the competence sheet effectively measure your ability to solve abstract problems?**
- Yes.
- 8) **What do you think of the current way of keeping track of and updating the competence sheet?**
- I would prefer not doing it in excel and see my progress in a clearer way. I think it was hard to see where I improved in the current solution. It would be nice to how I compare to my department.
- 9) **What are your thoughts about turning the competence sheet into a web-based system?**
- That would be great. So I can log in and maybe when i have reached a level for a competence and update it when I want to instead of quarterly.
- 10) **Are there any special features that you would like to have if the web-platform is to be implemented?**
- I would like to see how i compare to others, not specific persons but in general. Trending competencies. A separation of back-end/front-end/database. Show where we're strong and where we're weak. The views should not be different for managers and developers(Data transparency).

E. Interview 5

- 1) **What is your position in this firm?**

- project manager and project maintenance.
- 2) **For how long have you been working here?**
 - 3 and half years
- 3) **How long have you been working in the field? How would you summarize your experience? In terms of working experience.**
 - 7 years. I have been at the same project from the start in sigma.
- 4) **What is your involvement with the competency sheet? (did you use it? Did you help create it?)** - I fill it in when my supervisor asks me to.
- 5) **What is your general impression of measuring competence in software engineering?**
 - It is easier in software engineering than project management. It was easier for me to judge my competence as a manager than now as a project manager.
- 6) **How do you feel about the way competency is measured in this company?** - It's pointed towards developers. It's not valued for project manager. It doesn't say much about him as a project manager and is not that impactful.
- 7) **Do you think it accurately reflects your competence?**
 - The idea is not that bad, since it's more or less programming languages, database, and so. This is not relevant to me since I do not program at all. If I was a developer I think it works well for developers.
- 8) **What do you think of the current way of keeping track of and updating the competence sheet?** - It's not easy to keep track of it, it's not hard but since it's not frequently updated he needs to search for the file whenever he needs to update it. If you can find a way to make it more useful to use it weekly that might be better. I need to search for it through past emails which is a bit annoying and slow.
- 9) **What are your thoughts about turning the competence sheet into a web-based system?**
 - Good a lot better that it is becoming a web platform.
- 10) **Are there any special features that you would like to have if the web-platform is to be implemented?**
 - The sheet should be more specific to your role, otherwise I think it works fine. It's hard to evaluate your own competence since it's hard to measure soft skills. If I am a developer now and I would like to become a project manager it might be better to be able to view them and see how I can become one.

F. Interview 6

- 1) **What is your position in this firm?**
 - I am technical project manager.
- 2) **For how long have you been working here?**
 - Almost 4 years.
- 3) **How long have you been working in the field? How would you summarize your experience? In terms of working experience.**
 - 18 years, good.
- 4) **What is your involvement with the competency sheet?**

(did you use it? Did you help create it?) - I use it, but I think it's aimed towards developers and not me.

- 5) **What is your general impression of measuring competence in software engineering?**
 - People lie in their CV. In Sweden people usually know more than what's on their CV. But it's the other way around. I don't think it's good to use something that people fill in themselves. I have not dealt with competence measuring before.
- 6) **How do you feel about the way competency is measured in this company?**
 - It's good for the individual user since it gives you goals to go for. So I think it's a good idea. In a big company like sigma it could be a good first selection tool to find people, but not for me in my current role.
- 7) **Do you think it accurately reflects your competence?**
 - I think it's accurate but we should have 1 to 4 instead.
 - a) **Does the competence sheet effectively measure your ability to solve abstract problems?** Yes
- 8) **What do you think of the current way of keeping track of and updating the competence sheet?**
 - I don't know where my sheet is right now, but then again it's not for me.
- 9) **What are your thoughts about turning the competence sheet into a web-based system?**
 - I think it's a good idea to turn it into a web platform.
- 10) **Are there any special features that you would like to have if the web-platform is to be implemented?**
 - No special ideas, since I have not used the excel sheet a lot.

G. Interview 7

- 1) **What is your position in this firm?**
 - Manager
- 2) **For how long have you been working here?**
 - Five years.
- 3) **How long have you been working in the field? How would you summarize your experience? In terms of working experience.**
 - For twenty one years.
- 4) **What is your involvement with the competency sheet? (did you use it? Did you help create it?)**
 - I don't fill it in. It's made for the developers. It's there to show what competences are needed and there are around 100 right now. It's not only used by us managers but by many other different roles as well. It can be applied to a lot of fields other than development as well.
- 5) **What is your general impression of measuring competence in software engineering?**
 - I don't think its about measuring the competence. It's more to show what we know right know and what we want to know. It's not measurement that decides your salary or prestige in the company. It's all about inspiration to improve and evolve. Seeing goals that you can achieve by learning is a really good thing in my opinion.

6) **How do you feel about the way competency is measured in this company?**

- People seem to like it a lot. Everyone think its a clear way to show what we need to focus on. I have only received positive feedback so far. No one sees it as a negative thing being measured by having any pressure put on them, only gains. Because it is very new the updating part is the only negative aspect.

7) **Do you think it accurately reflects your competence?**

- Yes I think so. Reality is very close to what people have written. If someone got low competence in something we take that into consideration when assigning tasks. People have been honest putting honest answers. And we have been clear about that it is to show how you can improve, it does not increase your status or salary. That in my opinion encourages honesty.

a) **Does the competence sheet effectively measure your ability to solve abstract problems?**

- Yes I think so.

8) **(If creator) Does the competence sheet perform as expected in practice?**

- Yes, the results are very close to what is presented in the sheet.

9) **(The assigner of tasks) Has the assignment of the tasks been successful?**

- Yes I think so.

10) **What do you think of the current way of keeping track of and updating the competence sheet?**

- It is a bit complicated at the moment. We made it and sent it to everyone and then got a filled in version back. It's very manual and time consuming for us managers. Comparing them is even harder.

11) **What are your thoughts about turning the competence sheet into a web-based system?**

- Very good. Going to simplify filling it in and evaluating the results. Will give us a good overview of our current competence.

12) **Are there any special features that you would like to have if the web-platform is to be implemented?**

- A comparison of the results. Showing how you have improved over time. To be able to fill it in whenever you want. Making it into a mobile application or responsive web application. Making it simple to fill in and evaluate. Some explanation of what the subjects mean. Sometimes people write they have a bad score in a subject because they don't know what the name means.

H. Interview 8

1) **What is your position in this firm?**

- Developer

2) **For how long have you been working here?**

- Five years.

3) **How long have you been working in the field? How would you summarize your experience? In terms of working experience.**

- Five years as well. I've worked with mobile apps and sales before. Brainstorming and workshops. There weren't many mobile developers back then. I was involved in most of the processes when it started.

4) **What is your involvement with the competence sheet? (did you use it? Did you help create it?)**

- I have never used it to assign people. It's more about showing the competence and match it to requests. I just full it in.

5) **What is your general impression of measuring competence in software engineering?**

- Obviously you need to measure it in some kind of way to see who got the right competence. But I guess the best way to measure competence is yearly experience. However that can only be used in your main area of expertise. But putting a level system is better than selecting "Senior" or "Junior".

6) **How do you feel about the way competency is measured in this company?**

- I think it's better to have a 1-5 scale than a junior/senior scale. It's hard to say if you're 1-5 unless the scale is defined properly with information. I think the system at this moment with the excel file is not a good thing and hoping new better things are to come.

7) **Do you think it accurately reflects your competence?**

- Yeah I think it does. However, I do think in my position within mobile applications we have architects and managers that decide the competence you need to reach senior/junior. Their decisions are not always up to date and unused languages and frameworks might still be there. A filter should be a way to have an influence over the competence.

a) **Does the competence sheet effectively measure your ability to solve abstract problems?**

- Yes.

8) **What do you think of the current way of keeping track of and updating the competence sheet?**

- Not very well. It works but only once a year before you talk to the manager and get asked to do it. Most of the people do it in time but a lot of them also might be late and forget to do it. It should be able to be updated whenever you want to. As soon as you learn something it should be updated.

9) **What are your thoughts about turning the competence sheet into a web-based system?**

- I think it's great. I know the mobile application feature is a bonus but I think it would be great if you can do it on your phone.

10) **Are there any special features that you would like to have if the web-platform is to be implemented?**

- Phone or tablet functionality. Competence to be added through suggestion form. All the features the current excel macro has should be there.

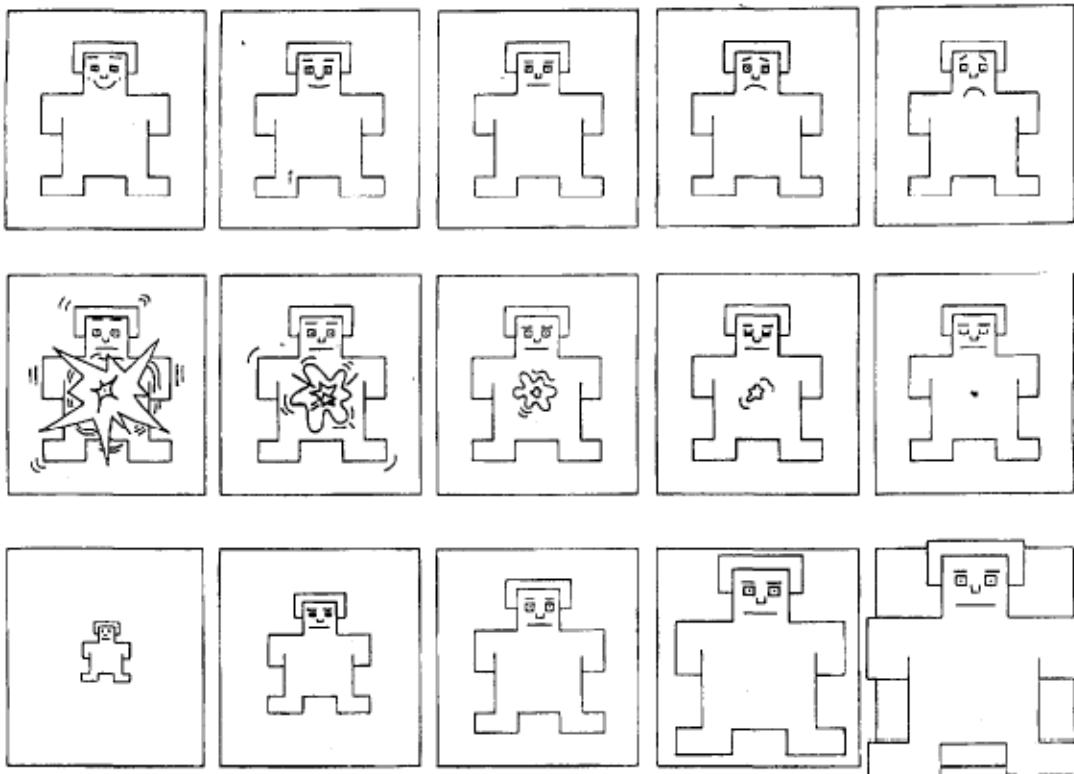
USER STUDY DESIGN

- User study will be composed of two parts:
 - PART A: User study part with “competency sheets”
 - Task with competency sheets
 - Conduct Self-Assessment Manikin (SAM) *[Write ID of user and “PART A” on SAM sheet]*
 - Conduct Intrinsic Motivation Inventory (IMI) *[Write ID of user and “PART A” on IMI sheet]*
 - PART B: User study part with “web-based competency system”
 - First a brief demo --- All functionalities – lasts 2 minutes
 - Task with Web-based Competency system
 - Conduct Self-Assessment Manikin (SAM) *[Write ID of user and “PART B” on SAM sheet]*
 - Conduct IMI *[Write ID of user and “PART B” on IMI sheet]*
 - Small Interview
- There are total of 8 participants and 1 participant for the pilot study
- Keep a table that matches names & surnames of participants with their ID (ID values are like 1, 2, 3, ...). Once the study is completed this table will be destroyed and removed. Results of the study will be reported anonymously.
- Flipping the order of PART A and PART B:
 - Randomly selected 4 participants will be conducted first PART A and then PART B
 - The remaining 4 participants will be conducted first PART B and then PART A
- PART A and PART B will be done altogether (i.e., PART A will be immediately followed by PART B, and for the flipped case PART B will be immediately followed by PART A.).
- All user studies will be recorded.
- The only difference between PART A and PART B is the difference of the tasks. In PART A, the task is with the “competency sheets” and in PART B, task is with “web-based competency system”.
- User study conducted to developers is different than the user study conducted to the managers in the following ways:
 - Task with competency sheets
 - Task with competency sheet for developers
 - Task with competency sheets for managers
 - Intrinsic motivation inventory (IMI)
 - IMI for managers
 - IMI for developers
 - Task with web-based competency system
 - Task with web-based competency system for developers
 - Task with web-based competency system for managers

Self-Assessment Manikin (SAM) Protocol

- Show SAM to the participant and say the following:
 - *“You will be rating the task you have just completed in terms of how it made you feel while viewing it. There are no right or wrong answers, so simply respond as honestly as you can.*
Here you see 3 sets of 5 figures, each arranged along a continuum. We call this set of figures SAM, and you will be using these figures to rate how you felt while doing the task you have just completed. You will use one page-- make all 3 ratings -- for each picture that you observe. SAM shows three different kinds of feelings: Happy vs. Unhappy, Excited vs. Calm, and Controlled vs. In-control.”
- Explain the first row of SAM as follows:
 - *“You can see that each SAM figure varies along each scale. In this illustration, the SAM scale in the first row is the happy-unhappy scale, which ranges from a smile to a frown. At one extreme of the happy vs. unhappy scale, you felt happy, pleased, satisfied, contented, hopeful. If you felt completely happy while viewing the picture, you can indicate this by placing an ‘X’ over the figure at the left, like this (point on the sheet with index finger). The other end of the scale is when you felt completely, unhappy, annoyed, unsatisfied, melancholic, despaired, bored. You can indicate feeling completely unhappy by placing an ‘X’ on the figure at the right, like this (point on the sheet with index finger – touch all figures in the first row with index finger). The figures also allow you to describe intermediate feelings of pleasure, by placing an ‘X’ over any of the other pictures. If you felt completely neutral, neither happy nor sad, place an ‘X’ over the figure in the middle. If, in your judgment, your feeling of pleasure or displeasure falls between two of the pictures, then place an ‘X’ between the figures, like this (point on the sheet with index finger). This permits you to make more finely graded ratings of how you feel in reaction to the pictures.”*
- Let the user mark on the first row
- Explain the second row of SAM as follows:
 - *“The excited vs. calm dimension is the second type of feeling displayed here in the second row. At one extreme of the scale you felt stimulated, excited, frenzied, jittery, wide-awake, aroused. If you felt completely aroused while viewing the picture, place an “X” over the figure at the left of the row, like this (demonstrate with SAM4). On the other hand, at the other end of the scale, you felt completely relaxed, calm, sluggish, dull, sleepy, unaroused. You can indicate you felt completely calm by placing an “X” over the figure at the right of the row, like this (demonstrate with SAM5). As with the happy-unhappy scale, you can represent intermediate levels by placing an “X” over any of the other figures. If you are not at all excited nor at all calm, place an “X” over the figure in the middle of the row. Again, if you wish to make a more finely tuned rating of how excited or calm you feel, place an “X” between the pictures, like this. (demonstrate with SAM6)”*
- Let the user mark on the second row

- Explain the third row of SAM as follows:
 - *The third row is the last scale of feeling that you will rate is the dimension of controlled vs. in-control. At one end of the scale you have feelings characterized as completely controlled, influenced, cared-for, awed, submissive, guided. Please indicate feeling controlled by placing an "X" over the figure at the left, like this (demonstrate with SAM7). At the other extreme of this scale, you felt completely controlling, influential, in control, important, dominant, autonomous. You can indicate that you felt dominant by placing an "X" over the figure at the right of the row, like this (demonstrate with SAM8). Note that when the figure is large, you feel important and influential, and that it will be very small when you feel controlled and guided. If you feel neither in control nor controlled you should make an "X" over the middle picture. Remember you can also represent your feelings between these endpoints. Either place an "X" over any of the intermediate figures, or between them--like this (demonstrate with SAM9)."*
- Let the user mark the third row.



Intrinsic Motivation Inventory (for developer)

For each of the following statements, please indicate how true it is for you regarding the task you have completed, using the following scale

1	2	3	4	5	6	7
not			somewhat			very
at all true			true			true

1. I was anxious while working on this task
2. I felt very tense while doing this task
3. I tried very hard on this task.
4. I was very relaxed in doing the task
5. I believe doing this task could be beneficial to me.
6. I think I am pretty good at this task
7. This was a task that I couldn't do very well.
8. This task was fun to do
9. This task did not hold my attention at all
10. I didn't feel nervous at all while doing this task
11. I would describe this task as very interesting
12. I put a lot of effort into this task.
13. I think doing this task could help me to **monitor my competency.**
14. I think I am pretty good at this task
15. I think this is important to do because it can help me **find out the resources (e.g., tutorials, documentation, etc.) that can help me improve in areas that I want to improve myself.**
16. It was very important for me to do well at this task.
17. I didn't try very hard to do well at this task.
18. I thought this was a boring task
19. I felt pressure while doing these
20. I think doing this task is useful to **improve my progress in my competency**
21. I would be willing to do this, because it has some value to me

Intrinsic Motivation Inventory (for manager)

For each of the following statements, please indicate how true it is for you regarding the task you have completed, using the following scale

1	2	3	4	5	6	7
not			somewhat			very
at all true			true			true

1. I was anxious while working on this task
2. I felt very tense while doing this task
3. I tried very hard on this task.
4. I was very relaxed in doing the task
5. I believe doing this task could be beneficial to me.
6. I think I am pretty good at this task
7. This was a task that I couldn't do very well.
8. This task was fun to do
9. This task did not hold my attention at all
10. I didn't feel nervous at all while doing this task
11. I would describe this task as very interesting
12. I put a lot of effort into this task.
13. I think doing this task could help me to **find the matching developer for a profile with a specific competency.**
14. I think I am pretty good at this task
15. I think this is important to do because it can help me **find programming languages the developers are strongest and weakest at.**
16. It was very important for me to do well at this task.
17. I didn't try very hard to do well at this task.
18. I thought this was a boring task
19. I felt pressure while doing these
20. I think doing this task is useful to **competency information about a given developer.**
21. I would be willing to do this, because it has some value to me

Interview Questions:

1. (If creator of competence sheet) Does the web based system perform as expected in practice?
2. What do you think of the keeping track of and updating the web-based competence system?
3. What are your thoughts about turning the competence sheet into a web based system?
- 4.

Feedback Questions (These questions will be asked to the participant after the pilot study):

- Ask about how he finds the explanations about SAM. Are they too long or ok, are they clear or vague?
- Ask if all SAM instructions should be given in advance before asking the participant to mark his choice for all three. Or if making an explanation before user markers each row is ok?
- Ask about the statements which do not make sense in IMI
- Ask if he finds IMI long
- Ask for further comments about the user study

APPENDIX G
EVALUATION INTERVIEW DATA

1) *Evaluation interview 1:*

- 1) **What do you think about of the keeping track of and updating the web-based competence system?**
- I think it was good. Better and easier than before. More accessible in comparison to the sheet.
- 2) **What are your thoughts about turning the competence sheet into a web-based system?**
- Availability has been a problem with the sheet. People kept losing their sheets and the data is gone. Having everything available at the same spot as a living document is key. I really liked the ability to read about a subject you want to know more about.

2) *Evaluation interview 2:*

- 1) **What do you think about of the keeping track of and updating the web-based competence system?**
- Much more living than before. I like that a lot.
- 2) **What are your thoughts about turning the competence sheet into a web-based system?**
- It should have been automated into some kind of web-based platform from the beginning.

3) *Evaluation interview 3:*

- 1) **What do you think about of the keeping track of and updating the web-based competence system?**
- I think it is a simpler and easier process to go about this.
- 2) **What are your thoughts about turning the competence sheet into a web-based system?**
- It's a good and solid way to go. The profile and learn more functionality makes it awesome. There's no limitations to this so more functionality can easily be added.

4) *Evaluation interview 4:*

- 1) **What do you think about of the keeping track of and updating the web-based competence system?**
- It's time effective and has a lot of potential.
- 2) **What are your thoughts about turning the competence sheet into a web-based system?**
- Great, really great!

5) *Evaluation interview 5:*

- 1) **What do you think about of the keeping track of and updating the web-based competence system?**
- This is much better. The old way was working but the problem arrives when you're going to send the sheet to your manager. It is very hard to keep track of the data for both managers and developers.
- 2) **What are your thoughts about turning the competence sheet into a web-based system?**
- I think the biggest win on this is that you have one living document. Just log in and you have it, change something and it changes for everyone.

6) *Evaluation interview 6:*

- 1) **What do you think about of the keeping track of and updating the web-based competence system?**
- Good. The only thing I'm concerned about is that it needs to be extremely obvious when it comes to how you are supposed to fill it in. Other than that I think it is great!
- 2) **What are your thoughts about turning the competence sheet into a web-based system?**
- I think it is a very good idea. It is almost a must if the company wants it to be a living document.

7) *Evaluation interview 7:*

- 1) **What do you think about of the keeping track of and updating the web-based competence system?**
- Much faster and time effective. Could use some work but the core functionality is there.
- 2) **What are your thoughts about turning the competence sheet into a web-based system?**
- It should have been a web-based platform from the beginning because this should be something that shouldn't be a burden but instead it should be motivating for the users.

8) *Evaluation interview 8(Manager):*

- 1) **Does the web based system perform as expected in practice?**
- Yes I think so. However, it has some potential for improvement.
- 2) **What do you think about of the keeping track of and updating the web-based competence system?**
- It really simplifies the process and keeps the manual work at a minimum. I see great potential whereas I only see limitations to the old sheet we were using.
- 3) **What are your thoughts about turning the competence sheet into a web-based system?**
- If I was the one to decide back before the sheet was created I would've gone for this kind of system right away.

9) *Evaluation interview 9(Manager):*

- 1) **Does the web based system perform as expected in practice?**
- Yeah it's performing as expected, but ofcourse there are things that could be added to it. But I understand it is a matter of time in this case.
- 2) **What do you think about of the keeping track of and updating the web-based competence system?**
- I think the information will be the same but it will be much less manual work. It will be easier to keep track of the latest version.
- 3) **What are your thoughts about turning the competence sheet into a web-based system?**
- It's the correct way to do it. Keeping the data in a database and everyone working with the same file. Earlier it was done manually.