Understanding the Software Development Effort Estimation in Chilean Small Companies

Tomas Vera
Computer Science Department
University of Chile
Santiago, Chile
tvera@dcc.uchile.cl

Sergio F. Ochoa
Computer Science Department
University of Chile
Santiago, Chile
sochoa@dcc.uchile.cl

Daniel Perovich
Computer Science Department
University of Chile
Santiago, Chile
dperovic@dcc.uchile.cl

***Abstract*. This article presents an empirical study that identifies the most frequent effort estimation approaches used in operationally stable small software companies in Chile. Based on it, we intend to understand both, the reasons behind the selection of these approaches, and the opportunities to improve that activity. We found that all companies participating in this study use flavors of expert-based estimation techniques, which is not surprising. However, we identified that many companies have no other option, since they share human resources among their projects, which limits their capability to record trustworthy historical information. This aspect conditions not only the estimation technique that can be used, but also the capability of the company to perform quality control of their estimations and improve its estimation process.**

Keywords— software effort estimation, expert judgment, historical information, small software companies.

I. INTRODUCTION

For various decades, the academia and the industry have been proposing new ways to conduct the software estimations in order to make this activity more replicable, accurate and fast. An important part of this research has been focused on estimating large projects, since such a scenario has been the most challenging. The literature recognizes that the company size matters, since the particular characteristics of small software companies (SSC) make them different from medium-sized and large organizations [1, 5, 11, 13]. Therefore, we can expect to see particular estimation techniques (or adaptations of the existing ones) that fit the SSC characteristics [10, 11]. However, the literature do not says much about it, even considering that these organizations represent the major part of the development force worldwide.

In addition to the company size, several researchers claim that the culture, development strategy, and level of technical and business expertise of the company are also relevant for the estimation practice [2, 7, 11]. However, most empirical studies reported in the literature do not formally take into account these aspects neither. Therefore, it is not clear if the findings reported in those studies are representative small software companies, and particularly of those working in Latin America.

After an extensive search in the literature, we have found no work reporting these practices used in Chile or other similar countries of the region. Therefore, in order to gain knowledge about the state-of-the-practice in software effort estimation in Chilean SSC, this article presents the result of an empirical study that addresses the following research questions:

RQ1: What effort estimation practices are the most frequently used by Chilean SSC?

RQ2: Why do these companies use these practices?

The study involved ten operationally stable SSC. We chose studying SSC companies because they represent a major percentage of the software industry in Chile and worldwide [12]. In addition, we selected those that are stable in terms of business operation, because they have a better chance to count on suitable methods to perform their estimations.

In the study, we used a case report approach to find the answer to the stated questions. Particularly, we used semi-structured interviews to gather qualitative and quantitative information from these companies.

The results indicate that all companies use mainly variants of expert-based techniques to conduct their estimation, which is aligned with the findings reported in other studies [8]. The selection of this estimation approach is conditioned by the fact that most companies have no trustworthy historical information that allows them to use other approaches. Although it is well-known the key role that trustworthy historical information plays in software estimation processes, in this study we identified a new and transversal cause that threats the trustworthiness of the historical information. Such a cause is the sharing of human resources among the projects that run at the same time, which is a common practice in SSC. The complexity of keeping under control this sharing process limits the capability of the companies to record the historical information and then trust on it. Therefore, such an information is usually few or not considered by experts in their estimates.

This situation limits the capability of the SSC to properly determine and record the effort spent in their projects, and therefore, their capability to estimate future projects without an expert, determine the quality of their estimations, and improve their estimation process.

This paper is organized as follows. Section II presents and discusses the related work. Section III introduces the study, and presents and discusses the obtained results. Section IV shows the answers to the RQs and Section V indicates the study limitations. Section VI draws the conclusions and future work.

II. Related Work

Regardless the extensive research effort conducted to help practitioners improve their estimation processes, there is little empirical research about effort estimation particularly in small software companies. As many SSC use agile development approaches, we can infer that agile estimation methods can be suitable for them. Typically, these methods involve expert opinion, analogy, disaggregation, and mixes of them [3, 17, 18]. Examples of the methods are planning poker, T-shirt sizes, dot voting, the bucket system, affinity mapping, and ordering method [3]. A field study conducted by Usman et al. [18] in the software industry indicated that all methods used by the study sample involved the participation of an expert, and that planning poker was the most frequently used technique. Sixty companies from five continents (16 countries) participated in the study. However, it did not differentiate the results by company size or region. Therefore, it is not clear how representative can be these numbers for our study scenario.

From a broader perspective and after conducting several studies on European industrial settings, Jørgensen [8] states that expert-based estimations are still the dominating approach, regardless of the extensive research done on formal estimation models. This claim is also supported by other studies [11, 16, 17]. However, no reports were found indicating the state-of-the-practice about effort estimation in SSC.

A literature review conducted by Vera et al. [19] on taxonomies of software effort estimation techniques shows that context attributes, like company size or culture, are not used to classify or characterize the estimation approaches. This confirms the low relevance given by the software engineering community to the company size or culture, when they intend to determine the state-of-the-practice in this study domain.

Provided this lack of empirical information, and recognizing the diversity of small software organizations, we conducted a field study trying to understand the state-of-the-practice in Chilean SSC. The next section introduces such a study.

III. Study Description

Ten small software companies participated in this study, which involved an individual and semi-structured interview, and then a follow-up interview to clarify answers. Next, we explain the design of this empirical study and the obtained results.

A. Company Selection Process

We defined inclusion and exclusion criteria to determine which companies could be invited to participate in this study. The inclusion criteria considered that the organizations should be formally a Chilean company with the headquarters in Santiago city, be at least three years old, have a stable business operation, and develop software for third parties. In addition, the companies should have between 10 and 49 employees, have at least 75% of personnel participating in software development, and perform effort estimations in their software projects.

The exclusion criteria considered companies with a size different to small, a main core business different to software development, or where the people in charge of the estimations were not accessible. Companies were also excluded when the estimator had less than one and a half years of experience estimating software in the organization.

Using the list of companies reported by Fernández [6], and considering the selection criteria, we performed a preselection of software companies. Forty-four companies (out of 128) were invited by email to participate in the study, and fifteen of them accepted the invitation. Then, they were interviewed by email or phone to confirm they fulfill the participation criteria. Finally, ten companies were selected to participate in the study.

B. Design of the Interview Guide

The design of the questions included in the interview guide followed the process recommended by Kitchenham et al. [9]. Considering the RQs, we identified the knowledge to be obtained from the interviewee, and then we defined the set of questions that would allow us to gather such a knowledge, including the sequence in which the questions should be formulated. The questions were arranged in three tracks according to the type of information to be retrieved. After writing the questions, the items of the interview guide were reviewed to check that they were correctly formulated, the writing does not introduce a bias, and the questions are enough to gather the knowledge that we want to retrieve from the interviewees. Unnecessary questions were removed, and the unsuitable ones were reformulated. No additional questions were identified as required to answer the stated RQs. The final list of questions is the following:

- *About the organization and the interviewee*. These questions intend to characterize the organization and interviewee, gathering context information that is useful to enrich the analysis of the answers. Regarding the organization, we asked: *What is the company age? How many employees it has? How many people are involved in software development activities?* and *What business domains the company addresses?* Concerning the interviewee, we asked: *What is your role in the organization?* and *What is your seniority in the company?*
- *About the projects*. These questions were used to characterize the projects run by the company, and the way in which they are addressed. We asked: *What type of projects the company run? What are the most frequent ones?* and *What is the typical project duration?* Concerning the development approach, we asked: *What development strategy is typically used to address the projects? What is the typical team size? What are the main roles played by the team members?* and *Are these team members shared with other projects?*
- *About the effort estimation process*. The aim of these questions was to identify how the estimations are conducted in the company. Particularly, we intend to understand the reasons behind the practices they use. We asked: *Who estimates the projects development effort in the company? What strategy is used to estimate? Why does the company use such a strategy? Do you support the estimation with historical information?* and *Are the estimations under control or is there space for improving them?*

C. Information Gathering Process

The information gathering was conducted using semi-structured interviews [15], where the interviewer followed a predefined sequence of questions, not only about the estimation process, but also about the company and the projects. This allowed us to obtain also contextual information that enriched the analysis and understanding of the answers provided by the interviewed person.

All interviews were individual and recorded in audio under informed consent of the participants. The duration of the interviews was estimated in 30 to 45 minutes, and a follow-up meeting was done when clarifications were required. The audio records were then listened more than once to characterize the way in which the company estimates, identify contradictory or potentially false information, and be sure that key information was recorded for further analysis. All this information was anonymized, coded and then stored in a spreadsheet.

D. Data Processing Strategy

Once completed the spreadsheet, the results were analyzed by track; i.e., considering the information about the organization, the development projects and the estimation process. The potential findings were written, justified using other qualitative or quantitative information gathered in the interviews, and finally validated in a face-to-face meeting with the interviewees.

This data processing strategy adheres to the guidelines given in Seaman [14]. Then, the information inter-track was analyzed manually, using several criteria to arrange the information of the spreadsheet as a way to identify similarities and correlations. The process followed to identify and validate the findings was the same than the one used for the tracks. Finally, the RQs were answered using the findings and the additional information recorded in the spreadsheet.

E. Results by Track

This section presents the study results considering the already mentioned tracks; i.e., organization, development projects and estimation process. A cross-case analysis was defined for each track, considering the grouping variables as recommended by Eisenhardt [4].

About the organization and the interviewee. We characterize the companies and interviewees in terms of three variables, grouped in sector "A" of Table I. The *company age* is expressed in years. The *role that the interviewee plays in the organization* corresponds to founder, chief executive officer (CEO), chief operating officer (COO), chief architect officer (CAO) and team leader. The *rate of developers versus estimators* is expressed in three categories (low, medium and high). We consider this rate as high when it is between 60% and 100% of the company's personnel, medium when it is between 30% and 59%, and low in other case.

The mean age of the participating companies was 7.8 years, with a mode of 3 years and a median of 6.5 years. These numbers show that the companies have overcome the startup phase. Half of the interviewees were founders, and the rest of the participants played key roles in their organizations. In terms of the rate between the developers and estimators, the results do not provide interesting information when they are analyzed in isolation. However, it will be then correlated with information from the other tracks to try understand this result.

About the projects. We use seven variables to characterize the companies' projects and the way in which they conduct these developments (labeled as sector "B" in Table I). The *team size* specifies the number of full-time people regularly required to address a typical company's project. *Resource sharing* indicates whether the team members participle full-time in a single project (low sharing), in two projects simultaneously (medium sharing) or in three or more projects (high sharing), either planned or unplanned. We also consider the usual level of *business knowledge* that the team has (varying from very high to low) on the domain addressed by the projects. The *project duration* captures the number of weeks involved in running a typical project. For the development *lifecycle* we consider structured/waterfall, agile, and ad hoc for informal or unstructured processes. *The project acceptance* rate indicates the relationship between the number of budgets delivered to clients, and those accepted by them (i.e., projects estimated versus run), in a scale that ranges from very high (over 80% of acceptance), high (60-80%), medium (30-59%), to low (below 30%). The *project type* indicates if the company works mainly on a particular type of product/service (product oriented), if it develops diverse types of solutions depending on the clients' needs (general development), or both categories.

The results shown in Table I indicate that most companies work on projects of 3 to 4 months of duration, and address them using teams equivalent to 3 full-time people. The qualitative information indicates that *the projects' and teams' size represent a kind of template used by the companies to keep their estimations under control and manage the eventual project overruns (finding 1).* When the development effort required in the project is bigger, the companies intend to split it in subprojects that adhere the size they feel comfortable with.

Besides, 40% of the companies use a structured development method, 40% use agile and the rest use an ad hoc process. These results helps understand the rate of estimators versus developers mentioned before. According to the interview records, in structured developments there is only one person that estimates, whereas in agile developments many people estimate through collaborative strategies. This explains why in the first case the rate is typically low and in the second is high. The companies that use an ad hoc process involve more than one person in the estimations, but not the whole team. The companies in this category have a high budget acceptance rate, however the interviewees declared that it is because their

TABLE I. CHARACTERIZATION OF COMPANIES BY CLUSTER

	A	About the organization								B	About the development projects																				C	About the estimations									
Principal Variables	Age	Role of the interviewee					Estimators vs developers			Team size	Resource sharing			Business knowledge			Project duration	Lifecycle			Project acceptance					Project type		Historical data			Estimation effort			Commercial overestimation		Post-Project feedback		MMRE	
Value / Company	Value	Founder	CEO	Leader	COO	CAO	High	Medium	Low	Value	High	Medium	Low	Low	Medium	High	Very High	Value	Waterfall	Agile	Other	Low	Medium	High	Very high	None	Product Oriented	General Develop.	Formal	Informal	None	High	Medium	Low	Yes	No	Yes	No	Know	Unknown
company 1	3	x							x	6		x		x				12	x				x				x			x			x			x			x
company 2	25		x						x	3		x			x			12	x				x				x			x			x		x				x
company 3	7				x				x	3		x			x			12	x				x					x		x			x			x			x
company 4	5	x						x		3	x					x		12	x				x				x			x			x			x		20%	x
company 5	4	x					x			3			x				x	16		x				x			x			x		x			x		x		25%	
company 6	8			x			x			3			x				x	12		x		x					x	X	x			x				x		x		25%	
company 7	6	x					x			3			x				x	2		x					x		x			x			x			x		x		20%	
company 8	10					x	x			6			x				x	24		x			x				x	x	x			x				x		x		20%	
company 9	3	x						x		2	x					x		2			x				x		x			x			x	x				x	60%	x
company 10	7				x			x		3	x				x			16			x				x			x			x			x		x			20%	x
Summary	**AVG: 7.8**	**5**	**1**	**1**	**2**	**1**	**4**	**3**	**3**	**AVG: 3.5**	**3**	**3**	**4**	**1**	**3**	**2**	**4**	**AVG: 12**	**4**	**4**	**2**	**1**	**5**	**1**	**2**	**1**	**8**	**4**	**2**	**8**	**0**	**4**	**3**	**3**	**4**	**6**	**4**	**6**	**7**	**6**

projects are usually not expensive. They use an ad hoc process and low budgets to try access a larger number of clients.

The results also show that 60% of the companies are focused on product-oriented developments, which usually represents lower risk and more benefits for these organization; the other 40% are generalists or combine both types of developments. In this sense, there seems to be no relationship between this variable and the lifecycle used by the organization or their budget acceptance rate. Similarly, the time spent to conduct the estimation does not help them get projects; the final price does. However, spending time in the estimations usually helps companies reduce risks in the projects.

In companies using agile development, the people present two features: they have an important knowledge about the business domain being addressed, and they work in a single project at a time. The first feature is promoted because their development methodology makes the knowledge flows among team members, allowing all participants to have a shared understanding of the context, goals and domain addressed in the project. The second feature makes the use of such a knowledge to be more effective since the developers do not have to address frequent changes of working context.

In the case of companies using structured development, only the project leader knows about the business domain, becoming a bottleneck, a point of failure and the only one able to generate estimates. In addition, the level of sharing of human resources is medium or high (people work in 2-3 projects simultaneously) which usually indicates low productivity and effectiveness of the teams. Typically, the sharing of human resources is informal and on-demand. This situation jeopardizes the capability of the teams to keep a trustworthy record of the effort spend in each project.

About the effort estimations. As mentioned before, *all companies indicated to use expert-based techniques as their main approach (finding 2)*. In particular cases, some of them mixed expert judgement and the use of analogies for projects in particular domains, which is aligned to what was reported by Jørgensen for European software companies [8]. The SSC also use analogies for tailoring the project scope, splitting it so as fit their project template in terms of duration and team size.

In order to characterize the effort estimations conducted by the companies, we use the five variables shown sector "C" of Table I. The *historical data* reflects whether the company formally or informally use results (measurements) from previous projects in the estimations. The *estimation effort* indicates the effort spent by the people during the estimations, and ranges from high to low (more than 12 hours, between 4 and 12 hours, and less than 4 hours respectively). In some cases, the company uses a multiplier to *overestimate* the projects and thus reduces development risks. *Post-project feedback* indicates whether the company evaluates the quality of their estimation after a project is finished. Finally, the *mean magnitude of relative error* (MMRE) captures whether the companies knows it or not.

All companies preserve some kind of historical data, and most of them consider it informally in new estimations. Only two companies formally use historical data, that is, to use such data is part of their estimation process. However, the participants declared that they prefer that an expert interpret such information (instead of automatically processing it) as it gives them more confidence.

The characterization also indicates that almost half of companies overestimate the projects effort, independently of the lifecycle being used. Typically, companies using agile methods spend more time in performing the estimations than those using structured or ad hoc processes, simply because the former involve a more important number of people in the activity. This characterization shows something that can be foreseen for this type of company.

The last two variables in Table I show unexpected information. Most of the companies do not get post-project feedback on their estimations, and consequently they do not know the level of error of their estimations (MMRE). Particularly, companies 4, 9 and 10 in such a category, record the deviation between the expected and real product deployment date, but they do not know the effort required to develop the product; they just know the project duration. The companies having the estimations under control seem to be those using agile strategies.

F. Cross-Track Analysis of Results

In order to understand the rationale behind these results, we conducted a more in depth analysis of the previously presented information. In Table I we highlighted, with different colors,

three highly cohesive clusters of companies. The clusters are formed considering the type of development strategy the companies use. In yellow are companies 1 to 3 that use a structured development process (usually waterfall), in red are companies 5 to 8 using agile methods, and in green companies 9 and 10 that perform deadline-oriented developments. In this last category, the process used by the organizations is whatever they need to reach the milestones. Company 4 is an outlier that shares features with the first and the last type of company.

The preliminary analysis of the results seems to indicate that companies using agile developments tend to produce estimates that are more accurate and have the process under control. However, the in-depth analysis showed that this characteristic is not proper of the development approach, but instead, it is a consequence of keeping the development capability under control. In this case, people in the agile teams work in a single project with full-time dedication, which give these teams more capability to control the effort effectively spent in their projects. This leads us to the third finding: *sharing human resources among projects jeopardizes the capability of the companies to keep a record about the effort spent in their projects, and therefore, to record trustworthy historical data and perform quality control of their estimations (finding 3)*. The interviewees mentioned that sharing human resources informally and on-demand among projects is a frequent practice to try accomplishing the milestones. The lack of trustworthiness in the historical information helps explain why the participating companies prefer to conduct expert-based estimations.

The analysis of the interviews also indicates that the companies are conscious and willing to improve their estimation techniques. However, they do not know how to do it properly or are afraid to change something that is already working somehow.

IV. Evaluation of RQs

Concerning the *RQ1 (What effort estimation practices are the most frequently used by Chilean SSC?)*, the results indicate that all companies use flavors of expert judgement, with some minor considerations about analogy-based approaches. The reasons behind such a decision lead us to the *RQ2 (Why do they use these practices?)*. The study results indicate that most companies use these techniques because they have no trustworthy historical information to support their estimations. This is a consequence of their inability to control the effort spent in their projects, because they share human resources among projects on-demand and without conducting formal tracking of that.

A couple of companies participating in the study (both use agile methods) formally record this information. However, they preferred to use experts in the estimations not only because it is quite natural for their development approach, but also because the historical information is quite sparse and its level of validity change over time. In that case, the experts can interpret such information and consider it according to the project context being estimated.

Finally, all participants understand that their estimation strategies can be improved, and they would like to do it. However, we identified two obstacles for conducting such improvements: (1) they do not know how to improve their estimations in a safe way, and (2) they are afraid to change something that is somehow working for them. Addressing the second limitation seems to be more difficult than the first one.

V. Limitations of the Study

This study considers some threats to construction, internal and external validity. Next, we explain each of them.

Construction validity. Concerning the ten companies selected for this study, although the number is small, all participants addressed the inclusion and exclusion criteria indicated in Section III.A. Moreover, in the interviews we were aware of detecting information indicating that any of the participants should be excluded due to reasons not considered initially in this study. No controversial information was detected; therefore, we assume the sample is cohesive and appropriate to try understand the estimation process in the target population. Moreover, we did not detect contradictory information in the participant answers. In the data gathering process and the design of the interview, we followed the guidelines indicated by Singer et al. [15] and Kitchenham et al. [9].

Internal validity. In the processing and analysis of the study results, we followed the guidelines proposed by Seaman [14] and Eisenhardt [4]. All participants signed the informed consent, which allowed us to record the audio of the interviews, and therefore, to listen to those audio recordings more than once to retrieve accurate and contextualized information.

External validity. Concerning the generalization of the findings, the selected sample is cohesive and remains the characteristics of the target population (SSC stable in terms of business operation). However, a confirmatory study is required to determine its representativeness, and therefore, the capability to generalize these findings. We also recognize that these results are probably not representative of the whole spectrum of Chilean SSC, since the estimation practices usually change when the company improve its maturity. In that sense, this study intends to capture only the reality of SSC that are operationally stable.

On the other hand, the information used in this study was given by estimators of each company, therefore, it could be not completely accurate. However, no contradictory information was detected, and the answers of estimators belonging to companies in the same cluster, were quite similar. This indicates that the collected information is probably trustworthy.

VI. Conclusions and Future Work

It is recognized that micro and small software companies represent most of the software development capability worldwide, and their features make them different to medium or large software organizations. Several studies report that the SSC need particular practices that fit with their business reality, and software estimation is one of these practices.

However, few empirical research has been reported with focus on this target population; and particularly in Latin American countries. Therefore, it is not clear how well the

state-of-the-practice reported in the literature for western countries applies to this study domain.

Given this lack of information about the state-of-the-practice in Chile and other countries of the region, we conducted a case report that tries to understand which estimation strategies are used by operationally stable SSC in Chile, and why do they use such strategies. The study results allowed us to identify two main findings: (1) *the companies use expert judgement mainly due to their inability to count on trustworthy historical data*, and (2) *this inability to record trustworthy information is usually a consequence of the unplanned human resource sharing performed by the SSC*. Moreover, we also reached an unexpected finding that indicates (3) *these companies use a kind of template for addressing their projects; that is a maximum duration of 3-4 months and team size around 3 members*. The use of these templates allows the companies to reduce uncertainty of the estimates. Consequently, it seems that the estimation effort is focused on splitting the scope to fit the project template, instead of sizing the development effort to any scope.

To the best of our knowledge, this is the first report on software estimation in Chilean SSC, and one of the few ones conducted in small software companies. We expect the findings help advance the state-of-the-art and illustrate the state-of-the-practice in the study domain.

The next steps in this initiative consider confirming the study findings using a new sample of companies in the same domain, and supporting some SSC to improve their estimation processes in order to determine the main limitations for conducting such improvements.

REFERENCES

[1] Aranda, J., Easterbrook S., Wilson G. Requirements in the wild: How small companies do it. Proc. of the 15th IEEE Int. Requirements Engineering Conference (RE'07), Delhi, pp. 39-48, 2007.

[2] Boehm, B.W. Software Cost Estimation Meets Software Diversity. Proc. of the 39th Int. Conference on Software Engineering Companion (ICSE-C'17), Buenos Aires, Argentina, pp. 495-496, 2017.

[3] Cohn, M. Agile Estimating and Planning. Prentice Hall Professional Technical Reference, 2006.

[4] Eisenhardt, K. M., Building Theories from Case Study Research, Academy of Management Review 14, pp. 532-550, 1989.

[5] Fayad, M.E., Laitinen, M., Ward, R.P. Software Engineering in the Small. Communications of the ACM, 43(3), pp. 115–118, 2000.

[6] Fernández, D., Caamaño A. Business Plan: Sol 3 - Part II (In Spanish). Master thesis in Business Administration. University of Chile, Faculty of Business and Economics; 2017-01. http://repositorio.uchile.cl/handle/2250/144413. Last visit: June 2019.

[7] Jørgensen, M., Grimstad, S. Software Development Estimation Biases: The Role of Interdependence. IEEE Transactions on Software Engineering 38(3), pp. 677-693, 2012.

[8] Jørgensen, M. What We Do and Don't Know about Software Development Effort Estimation. IEEE Software, 31(2), 2014.

[9] Kitchenham, B. A., Pfleeger, S. L. Personal Opinion Surveys: Guide to Advanced Empirical Software Engineering, Springer London, 2008, ISBN 978-1-84800-044-5, 2008.

[10] Mondragon, O. Addressing infrastructure issues in very small settings. Proc. of the 1st Int. Research Workshop for Process Improvement in Small Settings, pp. 5–10, 2005.

[11] Moses, J., Clifford, J. Learning how to improve effort estimation in small software development companies. Proc. of the 24th Int. Conf. on Computer Software and Applications, pp. 522-527, 2000.

[12] Ochoa, S. F., Robbes, R., Marques, M., Silvestre, L., Quispe, A. What Differentiates Chilean Niche Software Companies: Business Knowledge and Reputation? IEEE Software 34(3), pp. 96-103, 2017.

[13] Richardson, I., Von Wangenheim, C.G. Why Are Small Software Organizations Different? IEEE Software 24(1), pp. 18–22, 2007.

[14] Seaman, C.B. Qualitative Methods in Empirical Studies of Software Engineering. IEEE Trans. Softw. Eng. 25, pp. 557-572, 1999.

[15] Singer, J., Sim. S.E., Lethbridge T.C. Software Engineering Data Collection for Field Studies: Guide to Advanced Empirical Software Engineering, Springer London, ISBN 978-1-84800-044-5, 2008.

[16] Trendowicz, A., Münch, J., Jeffery, R. State of the Practice in Software Effort Estimation: A Survey and Literature Review. In: Huzar Z., Koci R., Meyer B., Walter B., Zendulka J. (Eds.). Software Engineering Techniques. CEE-SET'08. Lecture Notes in Computer Science, Berlin, Heidelberg, 2008.

[17] Usman, M., Mendes, E., Weidt, F., Britto, R. Effort Estimation in Agile Software Development: A Systematic Literature Review. Proc. of the 10th Int. Conference on Predictive Models in Software Engineering (PROMISE'14), Turin, Italy. 2014 pp. 82-91.

[18] Usman, M., Mendes, E., Börstler, J. Effort Estimation in Agile Software Development: A Survey on the State of the Practice. Proc. of the 19th Int. Conference on Evaluation and Assessment in Software Engineering (EASE'15), Nanjing, China, 2015, pp. 1-12.

[19] Vera, T., Ochoa S.F., Perovich D., Survey of Software Development Effort Estimation Taxonomies. Technical Report TR/DCC-2018-2, Computer Science Department, University of Chile. March, 2018.