

EvaScrum: An assessment instrument to support the diagnosis of Scrum – results of two case studies

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ABSTRACT

The purpose of the process evaluation is to obtain relevant information in a qualitative and quantitative way about the current state in which a process is to support processes of evolution and continuous improvement. Scrum is one of the most used agile approaches, however, there some aspects that can hinder its implementation, e.g., lack of detail of artefacts and meetings that raises, including the timetables, application of the approach, among others. In this sense, and in order to facilitate the success in the implementation of Scrum, this paper presents EvaScrum, an assessment instrument that provides the opportunity to professionals and consultants to assess and diagnose the degree of implementation of Scrum through questions, metrics, a spreadsheet and a Web application. EvaScrum is based on Mr. Scrum; a reference model which provides a clear and complete set of process elements based on Scrum and EvaScrumTOOL, a web tool to manage the assessments. This paper presents the detailed analysis of two case studies in software development enterprises where EvaScrum was applied. The results obtained have allowed case study enterprises to identify improvement opportunities to carry out in the processes and projects where Scrum is being applied, all this, in a practical, useful and suitable manner which allow these types of enterprises, to assess and diagnose their implementations of Scrum with feasible resources both time and economically.

Keywords: Scrum, Assessment, Software industry, Case studies, Software process improvement (SPI).

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1. Introduction

Over the last decade, a strong and growing trend towards the adoption and use of agile approaches in the Small and Medium Software Enterprises (hereinafter referred to as SMEs SW) projects has been identified [1]–[3], due to different important reasons, between them: (i) failure with traditional frameworks: due to the low percentage of success in the projects carried out in SMEs SW by means of traditional methodologies (or plan-drive methods) [4], overcoming problems related to the constant change of requirements, budgets and products that do not satisfy the customer [5] and (ii) the versatility and benefits that agile approaches provide to work teams, and those that mainly focus on: improvement of productivity, quality, alignment between customers and development teams, anticipated results (time to market), fast return on investment (return on investment - ROI), flexibility and adaptation to manage changing priorities [1], systematic risk mitigation, enhance software quality [1], improve project visibility [1], among others. Currently, it is possible to find a wide portfolio of agile approaches widely used in the global software industry, among the most outstanding are: Scrum [6], Extreme Programming (XP) [7], Crystal Clear [8], Lean Software Development (LSD) [9], Adaptive Software Development (ASD) [10], Dynamic Systems Development Method (DSDM) [11], Feature-Driven Development (FDD) [12], Agile Unified Process (AgileUP) [13], Kanban [14], among others.

According to [1]; currently Scrum is one of the most used agile approaches in the last decade as support to software project management and product management with value delivery, even, this is used together and in a hybrid way with other approaches such as XP, which increases its use percentage by 66% according to [1]. Despite the growing interest in agile approaches, (v) problems when defining the sprint “time box” in relation to the team’s speed [15], [16], (vi) difficulty in defining the times and objectives of each meeting [17], (vii) problems in adequately generating the product backlog [17], (viii) lack of knowledge of the composition of the team due to informality [18], (ix) lack of knowledge of the level of detail in the user stories and (vi) doubts when generating and updating the Scrum artefacts, such as Impediment Log, Product Backlog, Sprint Backlog, amongst others. In addition, another type of problems was found when applying the approach, these are associated with the lack of training and knowledge of the roles [15], [17] as well as problems related to the change of focus and paradigm in the teams [17], [18].

Scrum allows enterprises and practitioners a certain degree of local adaptation, however, a fragmented adoption of the artefacts, meetings and flow of proposed elements in Scrum is considered as a bad idea by the creators of Scrum [6], [19], because this situation can affect the correct operation of Scrum and its elements. Therefore, the lack of a structure that facilitates the adoption and assessment is necessary, hence, its implementation in some cases is carried out informally, without a suitable application and institutionalization of the elements and practices that describe it [18], [20], even many enterprises fail [21], [22], this because of: (i) excessive informality, (ii) for the maintenance of bad practices that impede the daily work of the teams [5], [23], (iii) by false expectations, (iv) there are some enterprises that implement agile approaches without complying with the description and original guidelines of the approaches as well as the values and principles of the agile manifesto [5], [20], [24], [25] and (v) in addition, software companies do not know the difference between an optimal process based on Scrum and its processes, which encourages process debt and technical debt in projects.

Taking into account the above, the objective of this paper is to present an assessment and diagnostic instrument that allows knowing the degree of implementation of Scrum called EvaScrum, which allows enterprises, professionals and consultants to have the opportunity to compare, evaluate and identify improvement opportunities in relation to the Scrum. For this, EvaScrum makes use of activities described in Mr. Scrum reference model, which describes in detail 29 activities organized in phases, roles and artefacts [19]. According to the GQM approach, these activities are taken as goals, and from them 87 questions and their respective metrics are suggested, which allow to know and establish the degree of implementation of Scrum in different contexts. In addition, the paper shows that EvaScrum was applied in two software development enterprise case studies. This work therefore intends to support and guide enterprises toward the successful application of the agile Scrum approach, and therefore, facilitate its understanding, and consequently, minimize the subjectivity of its application and adoption, all this through elements presented in this study.

The rest of the paper is structured as follows: Section 2 presents the background and analysis of related works. Section 3 describe EvaScrum in terms of its purpose, objectives, general considerations taken into account its creation, the context, questionnaires and scale of measurement. Section 4 presents in a detailed way the application of EvaScrum in two case studies. Finally, the conclusions and lessons learned are presented, and future work is outlined.

2. Background: an analysis of the current situation

In the literature, it is possible to observe a growing number of proposals that try to support the evaluation of enterprises in different topics as well as: evaluation of processes according to different standards such as ISO solutions [26], [27], or de facto models such as CMMI, among others. Likewise, it is possible to find different solutions related to the evaluation of agile maturity such as: a reference model bases on agile values, principles and aspects of Scrum, XP and Kanban to foster the adoption of agility in the software industry [28], a reference model for software agility assessment called AgilityMod [29], other solutions propose agile adoption framework solutions, they are: [30]–[32]. On the other hand, there are some studies and surveys consisting of checklist focused on the evaluation of Scrum, e.g., Scrum Master Checklist [33] proposes 5 point Likert scale and 42 questions, Scrum Checklist [34] presents 5 point Likert scale and 80 questions, Scrum Self Assessment [35] proposes 60 questions as true or false, a maturity assessment model for Scrum Teams (which is not available) [36] includes 15 questions and a type of 5 point Likert scale, [37] suggests 91 questions and a 4 point Likert scale and EvaScrum suggests 4 points Likert scale and 87 questions, which are related to six phases and 29 activities with their respective metrics. The authors recommend using the proposals found as a discussion tool and not as an evaluation tool, since these lists only reflect the opinion of the authors. On the other hand, in [38]

an evaluation that allows us to know the strengths and weakness according 7 features such as: comprehensiveness, fitness for purpose, discriminativeness, objectivity, conciseness, generalizability, and suitability for multiple assessment of these and other agile proposals is presented. On the other hand, it has not been possible to find results of application cases in any of the related works found.

As can be seen, some solutions have been developed, however, few provide a complete and clear solution that facilitates the implementation of Scrum from the “what” must be taken into account, since; first, it is one of the most widely used project management approaches worldwide, and second, its implementation can be affected and hampered by various factors that affect its proper functioning; either from misunderstandings, partial implementation of Scrum elements, or suggesting adaptations that reduce the desired benefits.

3. EvaScrum assessment instrument

This section presents EvaScrum assessment instrument in detail describing: (i) its purpose, (ii) its objectives, (iii) general considerations taken into account its creation, (iv) the context, (v) questionnaires and scale of measurement and (vi) a tool for supporting the process assessment through a web tool called EvaScrumTOOL.

3.1. Context

EvaScrum is related to three layers, these are explained to below: (i) *Technological layer*: which is composed of EvaScrumTOOL, this is a WEB tool that allows enterprises to apply the EvaScrum assessment instrument to obtain the degree of implementation of Scrum approach, (ii) *Methodological layer*: this layer consists of an assessment tool for determining the degree of implementation of Scrum called EvaScrum. EvaScrum defines a set of questions and metrics from activity goals defined in Mr. Scrum reference model, which is presented thoroughly in [19], both goals, questions and metrics were defined using the GQM approach [39]. Likewise, to apply EvaScrum is possible to use an assessment process to support its implementation such as PvalCOMPETISOFT, which is a process for conducting process evaluation and its purpose is to generate reliable information to identify the strengths, weaknesses and risks of the software processes of an enterprise in a general way, this assessment process is part of METvalCOMPETISOFT and is presented thoroughly in [40], and (iii) *Conceptual layer*: this layer consists of: Mr. Scrum, which is a reference model based on Scrum, and it arises as a result of a characterization of Scrum. Mr. Scrum proposes a workflow which facilitates: (i) obtaining a transparent vision of the Scrum-based project management process by displaying it with a drawing, improving the understanding and allowing to focus on specific aspects, as well as: roles, meetings, artefacts, among others, therefore, (ii) it helps to establish the added value of each of the activities that make up the process and (iii) it allows to identify errors and gives the opportunity to improve the process from the reference model. Mr. Scrum and PvalCOMPETISOFT are beyond the scope of this paper and has already been presented in detail in: [19] and [40], respectively. Likewise, the elements described in the technological layer (EvaScrumTOOL) will be presented in detail in other pieces of work since are beyond the scope of this paper, which has focused only on the description of EvaScrum. The link <https://bit.ly/3mNtfpV> presents the relationships between EvaScrum and components.

3.2. General considerations

EvaScrum is consistent with agile approaches and it supports the diagnostic of enterprises. The EvaScrum solution has been developed in order to: (i) provide the elements necessary for carrying out the assessment of enterprises in the context of projects and/or processes focused on management projects based on Scrum, (ii) provide the necessary elements to carry out the identification of needs and opportunities for improving the projects management process based on Scrum of software enterprises and (iii) facilitate the evaluation of the processes of the enterprises in a fast and inexpensive way which can be apply to software enterprises in general.

3.3. Purpose and objectives

EvaScrum has been defined with the purpose of supporting in a clear way an agile assessing and as a result, to obtain reliable information about weaknesses and strengths of the degree of implementation of Scrum of an enterprise. Decisions in the improvement projects will be based on the improvement opportunities identified from this information.

EvaScrum defines the following objectives: (i) to perform a diagnosis of projects management process based on Scrum implementation of an enterprise through an assessment instrument, (ii) to establish/define the scope of the assessment based on the improvement goals of the enterprise and related to Scrum approach, (iii) to assess

the results and monitor the continuous improvement of quality of Scrum's elements defined in software management projects, which impact the deliverables and can provide enterprises evidence about how responsible the team is and (iv) allow the evaluation and continuous diagnosis of degree of implementation of Scrum in software enterprises.

3.4. Questionnaires and scale of measurement

EvaScrum was designed taking into account the steps outlined in the Goal, Question, Metric (GQM) paradigm [39], which proposes a measurement model made up of three levels of abstraction, they are: (i) Conceptual level (Goal), (ii) Operational level (Question) and (iii) Quantitative level (Metric). First, in conceptual level, the goals that would allow to quantify the elements (phases and activities) proposed in Mr. Scrum were identified, the list of phases and activities are available in [19] or through the following link: <https://bit.ly/3pBMbc4>. Second, a set of questions were designed from goals obtained in the conceptual level, these questions allow to focus and characterize the assessment or achievement of a specific goal related to Scrum. Finally, a set of metrics, based on conceptual level were associated with every question, this, in order to answer each question in a measurable way. Questions related to the goals and metrics were defined in order to obtain quantitative information that allows verifying the percentage of activities that a software development enterprise implements according to Scrum. As described by the GQM paradigm, it is necessary to define the business objectives and the measurement objectives in order to identify the objective and the limits of the project. Now then, a set of goals (business objectives) and a list of activities (measurement objective) are described for each of the phases. The phase is the element of higher level described in EvaScrum and its degree of implementation is obtained in relation to the achievement of the activities proposed for each phase. The list of questions defined in EvaScrum for each activity defined in Mr. Scrum is presented in <https://bit.ly/3uSeG79>. Likewise, a spreadsheet in Excel with the information about phases, activities, metrics and figures and automatic calculation of the Scrum compliance can be obtained at <https://bit.ly/3gk3EDT>.

EvaScrum defines six metrics that aim to measure and have quantitative information that allows us to verify the degree of implementation of Scrum at the level of phases, activities, and evaluation of these through a set of questions. In addition, there are activities that are called complementary since their implementation is of added value to the enterprise's Scrum process, likewise, there are activities that are mandatory and therefore their completion must be present in the process. Taking into account the above, a weight score of 70 or 30 is assigned to the activities, 70 for the mandatory activities and 30 for the activities that are complementary, this in order to give greater relevance to the activities that are considered mandatory (this information is detailed in Table 1, metric M3). The metrics defined are described in Table 1, this table organises the information around an identifier, entity, attribute, acronym, description, and equation, except the metric M0, all metrics proposed use the percentage as a unit of measurement.

The degree of implementation of Scrum is evaluated by means of one type of evidence: indirect; documents that show the fulfilment of an activity, direct; which is related to the products obtained as a result of an activity and comments; which are opinions and information shared by people participating in the process. For the qualification of the degree of implementation of the process, phases, activities, and questions, the scale established in the ISO/IEC 15504 [41] standard was used as a reference since they support the process according to the qualification of the process elements, which depends on the result obtained in the associated tasks and output results. Therefore, values are expressed on a discrete scale as follows: Not Achieved (NA) 0% to 15%, Partially Achieved (PA) 16% to 50%, Largely Achieved (LA) 51% to 85% and Fully Achieved (FA) 86% to 100%.

Table 1. List of metrics proposed in EvaScrum

	Entity	Attribute	Acronym	EQ
M0	Question	Value	vQ	Neither
	Description: The value of a question is the result obtained when answering a question. The range established to rate a question uses a qualitative and a quantitative range as follows: Never = 0, Hardly ever = 1, Regularly = 2 and Always = 3, where "Always" is the <i>Maximum value that can be obtained in the Question (MaxvQ)</i> .			
M1	Question	Degree of implementation	dQ	$\frac{dQ}{vQ}$
	Description: The degree of implementation of the question is equal to the <i>value of the Question (vQ)</i> selected on the <i>Maximum value that can be obtained in the Question (MaxvQ)</i> .			
M2	Activity	Degree of implementation	dA	$\frac{dA}{\sum dQ}$
	The degree of implementation of an Activity is the result of carrying out the <i>sum of the degrees of Question</i> obtained ($\sum dQ$) by each question divided over the <i>number of Questions (nQ)</i> .			

M3	Activity	Weight	Wa	$\frac{Wa = Waa}{\sum Waa}$
	The weight of an activity is the degree and qualification for each of the activities depending on the questions associated with each activity. In addition, it is important to note that a <i>Weight of activity was assigned (Waa)</i> depending on the relevance it has on Scrum, and the value of the activity is obtained in relation to the weight and the degree of each activity. Due to the number of activities this could vary depending on the phase it is necessary to normalize the weight of each activity, therefore, the weight of the activity is equal to the weight assigned to each activity on the <i>summation of the Weights assigned to the activities ($\sum Waa$)</i> for each phase. The <i>Weight of an activity (Wa)</i> takes the following values: 70 or 30, 70 for the mandatory activities and 30 for the complementary activities. After identifying the weight for each of the activities, we proceed to calculate the corresponding degree of each activity, this degree is calculated considering the number of questions and the degree of each answer.			
M4	Activity	Value	vA	$vA = Wa \times dA$
	The value of an activity will be equal to the product between the <i>Weight of the activity (Wa)</i> (see metric M3) and the <i>degree of Activity (dA)</i> (see metric M2).			
M5	Phase	Degree of implementation	dP	$\frac{dP = \sum vA}{* 100}$
	The degree of implementation of a phase is the element of higher level that presents in EvaScrum and its degree of implementation is obtained in relation to the achievement of the activities planted for each phase. In this sense, the degree of the phase is equal to the <i>summation of the value of the Activities (or $\sum vA$)</i> obtained multiplied by 100.			
M6	Scrum	Degree of implementation	dS	$\frac{dS = \sum dP}{nP}$
	Once the above metrics have been applied, the degree of implementation with the Scrum process for the enterprise presenting this evaluation is continued. The degree of implementation of Scrum (dS) will be equal to the <i>summation of the degrees ($\sum dP$)</i> for each phase on the <i>number of phases (nP)</i> . The result obtained will be equal to that posed in Table 6.			

4. Case studies evaluation

EvaScrum has been applied to give support to assess and diagnose processes of software projects managed with Scrum in two different small enterprises in Colombia which are part of the critical reference group according to the Action-Research method [42]. In order to evaluate EvaScrum, it was conducted two case studies following the protocol template proposed in [43]. The following subsections describe case studies in terms of their design, subjects, field procedures and analysis of results.

4.1. Design

To address this study, it was defined a main question: *Is the EvaScrum instrument suitable (useful and practical) for carrying out process assessment based on Scrum efforts in small software enterprises?* and other questions derived of the main question (i) *Does EvaScrum contain the elements necessary to evaluate the Scrum approach?* (ii) *Is effort suitable for software development enterprises?* and (iii) *Does the proposed solution enable software enterprises to obtain reliable information to serve as the basis for improving the Scrum implementation of their processes?* With these questions we seek to discover whether EvaScrum fulfils its main function adequately, if this is of practical use and whether this is suitable according to the reality of small enterprises. Moreover, taking into account the approach presented in [44], the design type of our case study is multiple cases with holistic design, since EvaScrum was applied in two case studies (multiple case studies) to assess the project management processes based on Scrum (a single unit of analysis). The measures used in the study were: the opportunities of improvement identified through EvaScrum, the effort used to carry out the diagnosing associated with EvaScrum (related to practical use and the reality of enterprises) and the benefits described by the enterprises involved (related to useful functions).

4.2. Subjects and analysis units

The software enterprises that participated as case studies are part of the critical reference group of this project, and each performed the Scrum implementation assessment with the support of one advisor in the EvaScrum application. As criteria for the selection of case study enterprises, the following requirements were taken into account: (i) the enterprise in which EvaScrum was implemented belongs to the context of software development and applies the Scrum approach, (ii) the enterprise is interested in carrying out the assessment in relation to this agile approach and (iii) the unit of analysis is the assessment instrument EvaScrum. The enterprise one has 25 employees, 12 years of existence, its focus is the national and international market, they have implemented ISO/IEC 15504 and Scrum in their projects, and these are focused on software development for the health sector.

The enterprise two has 15 employees, 10 years of existence, its focus is the national market, they have implemented Scrum in their projects, and these are focused on development of custom software, outsourcing and e-commerce, it is focusing also on state tenders. For the case study EOne the enterprise had one of the project leaders who plays the role of Scrum Master for this project, this person knows in depth how the enterprise performs the agile methodology and is the one who performs the test proposed by EvaScrum. For the ETwo case study, we were directly assisted by the enterprise's executive director, who in addition of carrying out the evaluation, provided information about all the processes that take place in the enterprise when the different projects are faced.

The two enterprises shared one adviser. Two people was in charge of reviewing the quality of the article and the scientific method applied to the case studies. Adviser oversaw preparing: (i) the assessment instruments and (ii) how to analyse and summarize the information produced by them. Likewise, they also carried out the assessments in each one of these enterprises and provided the advisor of them.

4.3. Field procedure and data collection

The procedure for fieldwork and data collection during the case studies is closely related to the PvalCOMPETISOFT presented in [40]. The following subsections, a general description of the work done to assess and diagnose the processes in the two enterprises is presented.

Assessment planning. The advisor created an instrument to gather information, whose starting point/scope was to apply all the questions defined in EvaScrum, which are related to the list of activities defined by the reference model of Mr. Scrum. Findings of assessment surveys were included in the EvaScrumTOOL assessment tool, a screenshot can be seen in <https://bit.ly/3geUFns>. An initial assessment meeting planning was held with the executive director (ED) in each enterprise and additionally the project leader (PL) in ETwo in order to explain the planning of the evaluation, as well as putting in context the people involved in relation to three aspects: (a) what was going to be done, (b) who was going to do it and (c) how long would it take to do it. The meeting lasted approximately thirty (30) minutes for both EOne and ETwo. Once the agenda for the assessment was planned, two documents were sent by e-mail, a document that defines all the characteristics of EvaScrum and a spreadsheet that served as an assessment tool. The spreadsheet in Excel can be downloaded from <https://bit.ly/3gk3EDT>.

Assessment execution. The assessment was carried out with the executive director in both enterprises and additionally the project leader (PL) in ETwo. Once the assessments were made in EOne and Etwo, a meeting was held with the person delegated (executive director in both cases) to receive feedback and clarify any doubts that may have arisen. This meeting took approximately 45 minutes in EOne and 35 minutes in ETwo.

Generation and socialization of results. The data obtained was of different kinds and its purpose was to provide a view of the state of the enterprise's management processes according to Scrum. In this activity, the *evaluators* (the same advisor) used the information obtained and created the work product called *assessment report*. The numeric values of the twenty-nine activities assessed (shown in Table 2) were obtained from the measurement specifications proposed in Mr. Scrum (see [19]) and metrics defined in EvaScrum (see Table 1). An example of an excerpt of data obtained for case study EOne about how the measurements from the metrics defined were calculated is presented in the following link <https://bit.ly/3e9tHdU>.

Table 2 shows the distribution and percentage in the fulfilment of the twenty-nine activities proposed in Mr. Scrum and which are based on Scrum (values in %), both the percentage of activities and the degree of *dS* achieved by the case studies one and two are presented. Table 2 shows the activities related with each one of the phases defined by Mr. Scrum, they are: (a) Start Phase (activities 1-8), (b) Planning and estimation Phase (activities 9-14), (c) Implementation Phase (activities 15-17), (d) Retrospective and review Phase (activities 18-20), (e) Closure Phase (activities 21-24) and (f) Transverse Phase (activities 25-29). As can be noted, the enterprise EOne obtained 87% of the level of implementation of the activities evaluated by EvaScrum, which in general allows us to establish what the level of Scrum implementation is and how these could be classified, to illustrate, the level of implementation for EOne is FA or fully achieved, this is because the final result is between the range 86% - 100%. ETwo enterprise obtained 85% of the level of implementation of Scrum with the activities evaluated through EvaScrum (see Table 2), which in general allows determining an implementation degree of Scrum as: LA i.e., largely achieved, this because the final result is between the range 51% - 85%. The following link shows in a detailed way the questions related to activities and phases <https://bit.ly/3mOWmcp>.

Table 2. Scrum implementation degree in case studies EOne and ETwo

#	Phases	#	Enterprise One Activity value	Phase value	Enterprise Two Activity value	Phase value
1	Start Phase	1	91,66	89.6 (FA)	83,33	87.0 (FA)
		2	100		83,33	
		3	91,66		83,33	
		4	100		100	
		5	66,66		100	
		6	100		83,33	
		7	83,33		83,33	
		8	83,33		66,66	
		9	83,33		100	
		10	66,66		83,33	
2	Planning and estimation Phase	11	100	86.5 (FA)	100	88.3 (FA)
		12	100		100	
		13	93,33		86,66	
		14	73,33		73,33	
		15	91,66		100	
3	Implementation Phase	16	77,77	80.9 (LA)	55,55	76.3 (LA)
		17	80,95		71,42	
		18	66,66		55,55	
4	Retrospective and review Phase	19	86,66	78.1 (LA)	100	75.7 (LA)
		20	100		100	
		21	100		100	
		22	100		100	
5	Closure Phase	23	100	100 (FA)	66,66	95.8 (FA)
		24	100		77,77	
		25	83,33		83,33	
		26	100		100	
		27	91,66		83,33	
6	Transverse Phase	28	100	89.0 (FA)	83,33	84.8 (LA)
		29	66,66		88,88	
			(dS)		87 (FA)	

Discrete scale used in EvaScrum, NA, Not Achieved, 0%. PA, Partially Achieved, 16% - 50%. LA, Largely Achieved, 51% - 85% and FA, Fully Achieved, 86% - 100%.

As part of work product called assessment report which is one of those work products expected to be generated in this activity, twelve opportunities of improvement for the enterprise EOne were identified and ten improvement opportunities were identified for enterprise ETwo, they can be consulted through the following link: <https://bit.ly/3uZPagx>. The results obtained allow enterprises to carry out the definition of a general improvement plan based on a criteria prioritization of assessed elements, this allows enterprises to formulate and execute improvements in their processes to fully achieve the implementation of Scrum.

4.4. Analysis of results and lessons learned

Effort and Cost. Table 3 presents the effort and costs involved in the roles during the activities performed across the assessment process taking into account EvaScrum as reference to know the degree of implementation of Scrum. The activities to which the effort was analysed were: (1) assessment planning, (2) assessment meeting, (3) clarify doubts activity and (4) generation and socialization of results activity. Taking into account the effort made in these two enterprises, gives an idea about the amount of time required to carry out the assessment meeting activity for the first time, on average 40 minutes. It is necessary to bear in mind that the study enterprises involved are both very small enterprises, therefore, the cost of carrying out the inspection and evaluation activities were very similar.

In order to exemplify the costs associated with the case studies during the assessment, the average values taken into account in the calculation of the costs associated with roles in each case study were taken from PayScale [45]. With the results obtained about the cost, it is possible to observe that the costs associated with a leader during the Scrum implementation assessment are much lower than the costs associated with a leading evaluator of other models, e.g.: the related cost and effort for phase 1 and 2 of the audit of ISO/IEC 29110 is higher than Scrum, this one exceeds 1500 dollars for phase 1 and 2 [46], however, if we discriminate the cost associated with the activities of phase 1 and only focus on the cost associated with the audit of the phase 2, this is related to basic profile, which is composed of two processes: a project management (PM) process and a software

implementation (SI) process of the standard, and the cost related is of \$ 1000 dollars, although it is not clear the exact cost of the evaluation of PM process. In this sense, you might think that our proposal is suitable for small enterprises. With the associated costs, it is possible to think about the feasibility that enterprises can carry out surveillance audits as continuous improvement of the process, obviously, this increases the cost. It is also important to highlight that formalizing the Scrum assessment facilitates the evolution in the identification and improvement opportunities in the software industry, this is because it is currently one of the most used agile approaches.

Table 3. Effort and cost of the assessment process in case studies

Roles	EOne		ETwo	
Adviser – Certified Scrum Master (CSM)	X		X	
Executive director (ED)		X		X
Project leader (PL)				X
Activities performed	Effort by enterprise			
1 Assessment planning	30 minutes	30 minutes	30 minutes	30 minutes
2 Assessment meeting	45 minutes	45 minutes	35 minutes	35 minutes
3 Clarify doubts activity	30 minutes	30 minutes	30 minutes	30 minutes
4 Activity to generate and socialize results	160 minutes	30 minutes	150 minutes	30 minutes
Total effort by role	265 minutes	135 minutes	245 minutes	125 minutes
Total effort by case study	400 minutes		370 minutes	
Cost by average hourly rate take from PayScale [45], cost in dollars.	\$55.39	\$24.52	\$55.39	\$25.28 (PL)
Cost by role	\$244.63	\$55.17	\$226.17	\$52.66 (PL)
				\$51.08 (ED)
Total cost	299.8		\$329.91	

Analysis of the assessment instrument. Different actors have been considered to best address the threats and allow the validity plan to be carried out, they are described below: (i) both the design and the data collection plan were carried out by means of checklists proposed specially for software engineering case studies, see [47]; (ii) in order to maintain the validity of the construct and traceability, multiple evidence resources were used, such as: surveys, interviews and documentation. The evidence was obtained from the meetings held in the activities described in the field procedure; (iii) with regard to internal validity, it has been possible to establish that the implementation of EvaScrum in the case studies enterprises allowed to identify opportunities for improvement in their project and product management processes based on Scrum; (iv) regarding the external validity, EvaScrum was applied to two case studies enterprises, these were supported by two advisers (one for each enterprise). From the observations and lessons learned with the EOne case study, EvaScrum was validated and refined to be applied in the ETwo case study; and (v) in the research project presented here, the reliability of the results was ensured in the following way: (i) the replication material of the case studies was developed; (ii) the material allowed the enterprises to know the method and it was previously sent to them; and (iii) the case study was guided by the researchers (advisers) and the enterprises received immediate clarification in case of any doubt.

Limitations of the case studies. The case studies presented in this paper had some limitations, they are listed to below: (i) it is clear that the population consisting of only two case studies is a very small sample and the power of generalization of results is limited; and (ii) the bias in the case studies in relation to: the subjectivity in the development of some activities and the handling of data by the advisor. As mentioned in [48], in relation to subjectivity, attempts were made to reduce the subjectivity in the beautification of events/meetings held as more significant than they really were through the use of specific templates to capture data prior to subsequent analysis.

5. Conclusions and future work

In this paper, EvaScrum, an instrument to assess and diagnose the degree of implementation of Scrum is presented, which describes three layers to support its application in software enterprises: a conceptual layer, a methodological layer and a technological layer. In the conceptual layer a reference model called Mr. Scrum has been developed, this is a detailed description of elements defined in Scrum and it is the basis on which has been defined EvaScrum, which is in the methodological layer and takes the elements detailed in Mr. Scrum.

The application of EvaScrum has been carried out in two software development enterprises as case studies and the results obtained have been satisfactory. In case studies the unit analysis has been EvaScrum, and its

application have gave professionals, enterprises and researchers a set of elements to facilitate the adoption of Scrum, some of them are: definitions, flowcharts, activities, roles, metrics, spreadsheet for assessing and/or web assessment tool which allow enterprises to facilitate the Scrum agile approach assessment. EvaScrum was applied through two case studies by means of PvalCOMPETISOFT, a method defined in the COMPETISOFT project, this method allows to know in depth the steps to follow for the assessment of the processes and identification of the improvement opportunities of an enterprise.

From the initial application of the elements described in EvaScrum through the two case studies presented, it has been possible to observe that these are: (i) adequate to assess the Scrum implementation in enterprises that manage their projects through this approach; (ii) the effort (time and cost) involved is adequate to be applied in small enterprises; (iii) the solution has allowed serving as a base to identify opportunities for improvement of their project management process based on Scrum; and (iv) benefits described by enterprises, it can be seen that EvaScrum is: easy to apply, it is useful, it allows enterprises to assess and diagnose Scrum implementation completely.

In addition, the results of its application have allowed to currently carry out the improvement of the improvement opportunities detected in The EOne case study to continue with the scaling of Scrum through a scaled agile framework known as SAFe, this, due to the fact that currently the EOne case study enterprise faces the need to expand geographically and have distributed teams, however, they want that the local management of their projects to be faithful to Scrum and they consider that EvaScrum and other elements defined in ScrumAF enriches and facilitates this task. The ETwo case study is using the information and results obtained to address sensitive practices to improve, especially on practices related to the implementation phase.

As future work, a follow-up of the case studies will be carried out to establish that EvaScrum is being used as a tool to measure and know the degree of implementation of Scrum in the management of its projects. Similarly, to be able to know the evolution in the improvement of the practices of the case studies in relation to the previously obtained results. On the other hand, the application of the proposal will be carried out in more case studies and using EvaScrumTOOL, the developed web platform. The objective is to have a representative collection of case studies, which will allow us to have the necessary feedback from additional evaluations that refine, improve and validate our proposal.

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