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The making of an OMG standard

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ABSTRACT

In 2010 SEMAT launched a call for action to refound Software Engineering. Later, the Object Management Group endorsed it as a request for proposals to deal with SEMAT concerns. The KUALI-KAANS Research Group responded to the request as a submitter by creating the KUALI-BEH proposal. The objective of this paper is to present the roadmap KUALI-BEH followed throughout the OMG standardization process: its origins, fusion with the ESSENCE proposal and eventual appearance as a standard. The subsequent lessons learned highlight the lack of aligned definitions among IT standards and the standardization process shortcomings, to which improvements are suggested.

1. Introduction

The Object Management Group (OMG) [1] is an IT consortium that was established in 1989. The OMG is made up of organizations such as Microsoft, Boeing, Oracle, Ericsson and NASA, and is in charge of developing IT standards such as UML, XMI, CORBA and BPMN. OMG members form working groups called task forces, which are in charge of transforming initiatives into technology specifications.

In 2010 Software Engineering Method and Theory (SEMAT) [2], an important initiative for the software engineering community, emerged for the purpose of generating a theoretical basis for the discipline. Several influential members of the software engineering community participate in SEMAT, some of whom are involved in organizations that are OMG members. SEMAT determined the need to define fundamental concepts for practices, identify specific theories backed up by examples of their successful application, elucidate a set of universals and a kernel language to describe them, and establish a set of metrics to assess software practices, products and people [2].

The OMG endorsed SEMAT and made it a standard project: *A Foundation for the Agile Creation and Enactment of Software Engineering Methods RFP* (FACESEM) [3]; this project has provided the initiative with greater stability and visibility.

Owing to the fact that SEMAT was being closely followed by our research group, KUALI-KAANS assumed it as a promising line of work as soon as the RFP was published and responded to the FACESEM RFP with its own proposal, called: *KUALI-BEH: Software Project Common Concepts* [4].

In 2011, the OMG standardization process was started, and two proposals became involved: KUALI-BEH and *ESSENCE – Kernel and Language for Software Engineering Methods* [5].

The objective of this paper is to describe the roadmap followed throughout the OMG standardization process, from the creation of KUALI-BEH, its later fusion with ESSENCE through to its eventual (after three years) adoption as a formal OMG standard. The KUALI-KAANS background along with the experience in similar projects, the KUALI-BEH creation process and the specific steps followed during the OMG standardization process (in bold type) are shown in Fig. 1.

This paper is organized as follows: Section 2 presents the FACESEM RFP and its requirements, Section 3 describes the process followed by the research group to create a proposal, while Section 4 provides more details on the standarization process carried out in the context of the OMG. The lessons learned and the improvement opportunities are presented in Section 5. The conclusions and future work related to this experience are provided in Section 6.

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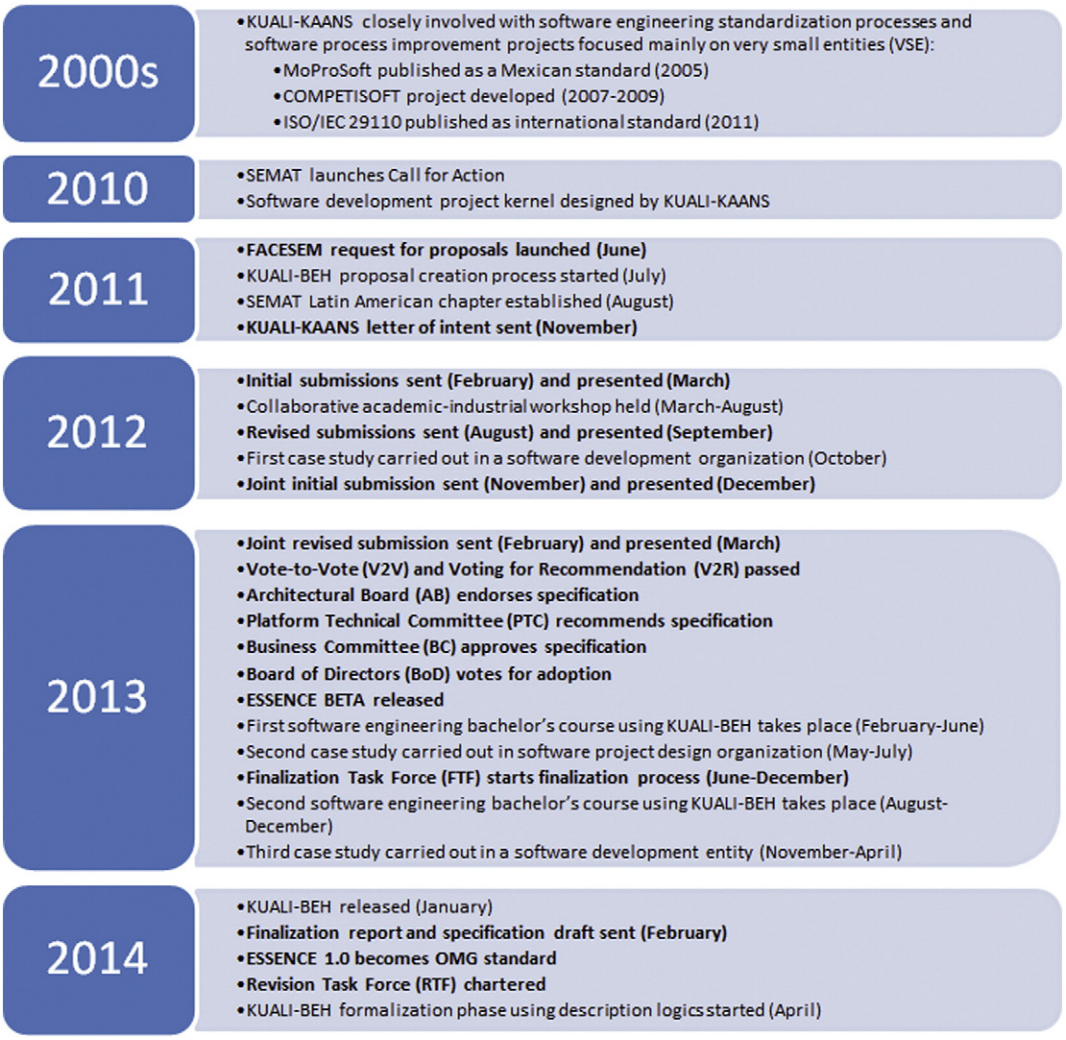

Fig. 1. KUALI-KAANS, KUALI-BEH and OMG milestones by year.

2. Background

As SEMAT and OMG are key elements of the standardization process described in this paper, this section presents the origin of SEMAT and expands on critiques made by an influential former signatory. In addition, a general background of OMG is provided, focusing on how an initiative of a future standard, the RFPs, came into being. Finally, a description of FACESEM RFP is presented as a direct result of SEMAT's concerns.

2.1. OMG background

The OMG is composed of 287 members, distributed in 8 different levels and focused on a wide range of markets. The group is in charge of developing enterprise integration standards for a wide range of technologies and an even wider range of industries [1].

These standards are created through task forces, which start their work by explicitly describing an initiative in the form of an RFP. The RFP brings together the general background, the rationale behind the initiative, a brief state-of-the-art of the context, mandatory and optional requirements and deadlines for the standardization process.

When the RFP is published, interested community members start creating their proposals. As soon as these are ready and the deadline arrives, these proposals are submitted as initial submissions to be evaluated by a task force. At this point discussion and collaboration between submitters actually begin.

Providing support for the standard creation process, the OMG organizes one-week technical meetings every four months, during which participants have discussions and make agreements that improve the initial proposals, turning them into revised submissions. This flow is repeated until an agreed proposal is developed and ready to be voted on by established OMG committees. If the results are favorable, the proposal becomes a beta version which enters the finalization step, the last step before becoming an adopted standard.

In an effort to provide a better understanding of the temporal framework presented in this paper, the general steps in the OMG standardization process are shown in Fig. 2. The OMG standardization process begins when an RFP is launched, after which initial and revised submissions are developed and sent to the OMG. Later the OMG members cast ballots to recommend and/or adopt the proposals. After that, the accepted proposal enters the finalization process and becomes publicly available. The post-adoption process, which includes revision, testing and, if needed, a retirement process, is the final step.

2.2. SEMAT origins and critiques

SEMAT came into being in three publications [6–8], in which the authors defined the reasons for creating SEMAT, which was motivated by

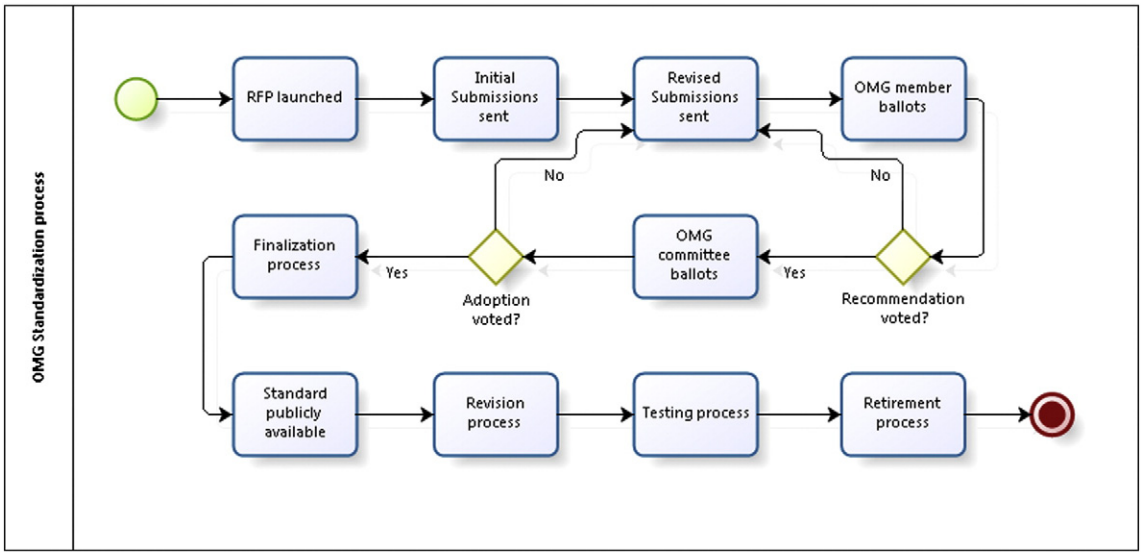

Fig. 2. General perspective of the OMG standardization process.

five problems: (i) the prevalence of fads in software engineering; (ii) the lack of a theoretical basis; (iii) the huge number of methods; (iv) the lack of experimental evaluation and validation; and (v) the split between industry and academia.

Although SEMAT is supported by many members of the software engineering community, who are convinced in its worth, there are a number of criticisms of the initiative. The author of [9] presents a detailed critique in which he analyzes SEMAT's Call for Action point by point, calling it "inflammatory, poorly researched and logically broken", issues that cannot be totally hidden or contradicted. In fact, throughout the process of creating the standard it became clear that the state-of-the-art analysis as presented left much to be desired.

The critical review accepts the fact that *"the state of research more indicates that we do not yet understand what is happening on software projects"* [9], but believes that *"nothing SEMAT can accomplish will affect this problem"* [9]. Far from trying to frustrate SEMAT supporters, as the author wrote, that critique is *"not to dissuade those already participating, it is to arm those who have not been participating in the discussions"*. A careful analysis of [9] shows that it is inviting readers to understand the ambitiousness and scope of SEMAT better, as well as to praise its beneficial moves and point out its mistakes.

An important idea in this critique is that SEMAT's effort can result in a *"meta-process-kernel allowing people to discuss the commonalities and differences of the inevitably ever-growing number of local software development processes"*, which is the main goal that the development of the standard described in this paper is trying to achieve, expressed in other words.

For the purposes of this paper, FACESEM, the OMG RFP that endorsed SEMAT concerns, is described in the next subsection.

2.3. Facesem Rfp

FACESEM RFP was prepared by the OMG task forces between December 2010 and June 2011. On 24 June 2011, the OMG Technical Committee voted to issue the RFP and made it publicly available.

The objective of the FACESEM RFP was to establish a foundation for the agile creation and enactment of software engineering methods by development practitioners themselves [3]. On the one hand, the RFP requested that a kernel of software engineering domain concepts and relationships be extensible, flexible and easy to use. On the other hand, it needed a domain-specific modeling language that would allow developers to describe the essentials of their current and future practices and methods [3]. In other words, the RFP requested a framework with which to describe, share and compare current ways of working in software engineering.

The resulting framework had to be guided by five principles: (i) the provision of foundations in order to be able to define methods and practices, both of which would be the central concepts of the framework; (ii) the inclusion of elements required to enact a method during an endeavor, focusing on what to produce and how to produce it; (iii) the definition of an operation with which to compose practices to build a method; (iv) the creation of an infrastructure in which to store practices and methods, thus allowing practitioners to understand, compose and compare them; and (v) targeting all of the above at software engineers and practitioners.

When the National Autonomous University of Mexico became an OMG member, KUALI-KAANS took the first step with regard to responding to the FACESEM RFP. The process of creating a proposal and becoming an official submitter is described in the following sections.

3. Creating the KUALI-BEH proposal

After the launch of the SEMAT Call for Action and the OMG endorsement, the FACESEM RFP was developed and made publicly available.

In 2010 KUALI-KAANS took the Call for Action seriously, creating an initial effort called Software Development Project Kernel (SDPK) [10]. SDPK was the first approach used to describe the elements of software endeavors. This work was presented in 2011 at the Latin American Symposium of Software Engineering (LASES'11) in Medellin, Colombia. LASES'11 was also the event at which the establishment of SEMAT's Latin American chapter was announced by Ivar Jacobson.

As a subsequent effort, another proposal named KUALI-BEH was developed in 2011. In contrast to SDPK, which responded to the SEMAT call, the KUALI-BEH project aimed to respond to the FACESEM RFP. The objective of this project was to identify a set of common concepts involved in software projects and later use them to express and structure software engineering methods.

KUALI-BEH was based on the knowledge obtained from recognized sources [11–21], as well as on the experience of defining software development standards [16,22,23], aimed principally at very small entities (VSE). KUALI-BEH is composed of static and operational views. The static view describes the common concepts that practitioners need when defining their ways of working. These ways of working are first expressed through practices, and are then compiled into methods. The operational view is related to the software project execution; it helps

work teams to enact a method and to adapt its practices to a specific context and stakeholder needs. The main target audience of KUALI-BEH is software engineering practitioners who can accumulate and share their knowledge with the help of KUALI-BEH's bottom-up approach.

3.1. State-of-the-art analysis

In order to attain an in-depth understanding of existing efforts surrounding the topic and analyze them, the first step was to study the state-of-the-art, starting with the RFP itself. As part of all RFPs, the OMG requests that a relationship be maintained with the existing OMG specifications and activities, and FACESEM RFP highlighted four of them in particular:

- An already adopted specification, the Software and System Process Engineering Metamodel (SPEM) [11], which guided us to the Eclipse Process Framework (EPF) [24];
- The Architecture Ecosystem SIG (AESIG), a special interest group that supports the creation, analysis, integration and exchange of information between modeling languages across different domains, viewpoints and from differing authorities [3];
- The Case Management Process Modeling (CMPM) RFP [25], which requests proposals that extend BPMN [26] to support the modeling of case management processes; and
- The Structured Metrics Metamodel (SMM) [27], which defines a metamodel with which to measure information related to software, its operation and its design [3].

A second section of the RFP requested the consideration of non-OMG related activities, documents and standards. This section in particular served as the actual starting point for the state-of-the-art review.

The RFP mentioned three ISO/IEC standards:

- ISO/IEC 15288 Systems and software engineering – System life cycle processes, which establishes a common framework with which to describe the life cycle of systems [20];
- ISO/IEC 24744 Software engineering – Metamodel for development methodologies, with the aim of establishing a formal framework for the definition and extension of development methodologies for information-based domains [12]; and
- ISO/IEC 12207 Systems and software engineering – Software life cycle processes, which establishes a common framework for software life cycle processes [14].

These standards use very similar words to describe their scopes: common, framework, describe/define and process. After reviewing them, the search was extended to another set of standards:

- ISO/IEC 15504 Information technology – Process assessment, which defines related concepts as well as a generic framework for software process assessment [15];
- ISO/IEC 29110-5-1-2 Software engineering – Lifecycle profiles for Very Small Entities (VSEs) – Management and engineering guide: Generic profile group: Basic profile, intended to be used by very small organizations to establish processes with which to implement any development approach or methodology [16];
- ISO 9000:2005 Quality management systems – Fundamentals and vocabulary, which cover the basic concepts and language of the ISO 9000 family [18];
- ISO/IEC TR 24774:2010 Systems and software engineering – Life cycle management – Guidelines for process description, whose purpose it is to provide guidelines for the description of processes by identifying descriptive elements and rules for their formulation [21]; and
- IEEE 1074-2006 IEEE Standard for Developing a Software Project Life Cycle Process, which provides a process that can be used to create a software project life cycle process [28].

Sources of knowledge such as process reference models, like CMMI [13], and bodies of knowledge, like PMBOK [19] and SWEBOK [29], were also analyzed. The analysis continued, moving on to a study of situational method engineering, which involves the harmonization and standardization of methods [30–32], as well as to a more recent study by Henderson-Sellers [33–35].

Software process metamodels were also analyzed: Process Interchange Format (PIF) [36], Process Specification Language (PSL) [37], Entry-Task-Validation-Exit method (ETVX) [38], Integration Definition for Function Modeling (IDEF0) [39], Core Plan Presentation (CPR) [40], Shared Planning and Activity Representation (SPAR) [41], PROMENADE [42] and SPEARMINT [43]. The agile approach was reviewed as well; the SCRUM Guide [17] was the principal study here, and the KANBAN and LEAN terminologies were also considered. Lastly, the work done by SEMAT provided an important input for the creation of KUALI-BEH.

3.2. Identification, definition and modeling

The results of the first stage were used as a basis on which to carry out a more in-depth bibliographical analysis of the theoretical aspects of software development projects. A refined search of common concept candidates to be included in the proposal also took place.

With regard to the aforementioned standards, metamodels, bodies of knowledge, process reference models and each source of knowledge explored, the following approach was adopted in the generation of KUALI-BEH:

1. First of all, the concepts used by software engineering project practitioners and those found in the literature were collected and listed.
2. Once the concepts had been found, their similarities and differences were analyzed in an effort to clearly establish whether or not they were equivalent; an arrangement of groups of similar terms therefore emerged.
3. A representative term was later selected from each group of concepts, after which a compatible definition was created, which was consistent with other terms in the group.
4. Finally, the focus was placed on associating the chosen elements with other relevant ones, in order to apply them in a software endeavor context.

After defining acceptance/rejection criteria for the candidates to join the common concepts of a software project, the items collected were analyzed and selected. Some of the acceptance/rejection criteria were:

- The concept's being explicitly required by the RFP.
- The commonness of the concept within analyzed sources.
- The concept's level of usage in industrial and academic contexts.
- The level to which the concept was accepted by practitioners.

20 common concepts and their relationships were defined and modeled through the use of a UML class diagram. A template-based representation and the software project common concepts were used to build examples of practices and methods in the quest to explore their expressiveness and sufficiency. The examples represent pre-defined practices of SCRUM and ISO/IEC 29110.

3.3. Verification & validation

In order to obtain feedback and evaluate the capability of representation, adaptation, comparison and sharing of knowledge using the software project common concepts, the proposal was opened up to discussion in the SEMAT community and its regional chapters; it then passed through five FACESEM task force meetings.

The FACESEM task force was in charge of the verification process, which was carried out through reviews based on the mandatory requirements defined in the RFP. Moreover, as part of each submission, an analysis and rationale of how the proposal satisfies specific requirements were presented in an informative annex.

The KUALI-BEH validation process was based on technical action research [44,45] and case studies [46,47]. The validation strategy was composed of six *engineering cycles*. During these cycles, evaluations were also carried out by other research groups, as well as via three case studies in real projects and a 6-month collaborative academic-industrial workshop with 19 participants from three organizations.

The results at that stage were promising, proving that KUALI-BEH was a valuable alternative that could narrow the gap between software engineering theory and practice. A detailed description and analysis of the results of the validation process, focusing on the collaborative workshop and the three case studies, is presented in [48], where threats to validity, limitations and lessons learned are discussed in depth.

At the end of this research phase KUALI-BEH 1.0 was released as an OMG initial submission. Several months later its improved version, 1.1, was released as an OMG revised submission.

3.4. Formalization

Having validated and discussed the common concepts for the software projects, mathematical formalism was then provided for its syntax and semantics to ensure that the statements constructed on their basis were consistent and formally verified.

An initial approach was created with which to share a common representation of knowledge as a set of concepts, attributes and relationships of a domain in the form of an ontology based on REFSENO [49]. In spite of the simplicity and usefulness of this approach, it was changed so that a consumable machine representation could be built. This objective was achieved using description logics, a language that allows the properties defined in KUALI-BEH to be modeled in order for them to be evaluated by a machine. This is the current and future work within the KUALI-BEH project, which will conclude with the release of KUALI-BEH 2.0.

4. OMG standardization process steps

After the KUALI-BEH project started, and having clarified that the purpose of the project was to respond actively to the FACESEM RFP, the research group had to become an OMG member and follow the standardization process of the consortium. This section explains the OMG standardization process followed by KUALI-BEH and KUALI-KAANS as part of the submitter team, and describes in more detail each step of the general process presented earlier, in Fig. 2.

4.1. Initial submissions

The first step that any of the OMG's member organizations must take if they wish to respond to the RFP with a proposal is to send a letter of intent (LOI). At the end of 2011, KUALI-KAANS sent an LOI to confirm its willingness to participate as submitters in FACESEM RFP. Five other organizations had also sent an LOI: Fujitsu, Ivar Jacobson International AB, Model Driven Solutions, PNA Group and Softeam.

On 20 February, 2012, the initial KUALI-BEH submission was sent to the RFP submissions desk at OMG Headquarters. 5 of the 6 LOI-organizations submitted three proposals. The proposals were published internally for OMG members. These initial submissions were:

- ESSENCE – Kernel and Language for Software Engineering Methods [50], whose submitters were: Fujitsu, Ivar Jacobson International AB and Model Driven Solutions, supported by 10 other organizations, such as the International Business Machines Corporation and Stiftelsen SINTEF.
- SEMDM ISO/IEC 24744:2007 Software engineering – Metamodel for development methodologies standard [12], submitted by Softeam.
- KUALI-BEH, submitted by UNAM.

The three proposals were placed in the OMG document server and the *Four-Week Rule* was applied. This rule states that *"any document to be presented to the membership for consideration (a poll) at a Technical Meeting must be available to the entire membership four weeks prior to the beginning of an OMG Technical Meeting"* [51], and its intention is to ensure an adequate period of time in which to review the proposals.

Four weeks after the submission, a technical meeting took place in Reston, VA, USA in March 2012. It was there that the Analysis and Design Task Force (ADTF) set the official presentations of the proposals for 21 March. A meeting organized by the submitters took place on the morning prior to the presentations. This meeting was attended by many members of the ESSENCE submission team, as well as by the two members of the KUALI-BEH submission team, while one person from SEMDM attended virtually.

During the meeting, each team had a timeslot in which to present their proposals briefly, and a discussion later took place, focusing on two points: a first-hand clarification of any doubts and questions related to the other proposals, and the indication of any elements that could be taken from each proposal to create a new one, as a next step. The meeting took place in a friendly environment and was, from our point of view, an introduction to the *OMG world*.

In the afternoon, the official presentations to the ADTF started. The objectives of the presentations are, according to [51]:

- To assess how well the submission(s) meet(s) the requirements stated in the RFP;
- To determine whether a vote to issue can occur, or whether it is necessary to make a change to the RFP Timetable.

As newcomers, we expected that a specific evaluation panel would be conducting the session, taking notes and asking questions, but this did not occur, or at least not explicitly. The session was directed by a chair in charge of protocol issues, who presided over the part related to questions and answers. The order of the presentations was SEMDM, KUALI-BEH and ESSENCE, followed by some questions that focused mainly on how each proposal would deal with risk management during a project, and why none of the proposals re-used SPEM, this being one of the hot topics at that time.

Moreover, the three graphical representations received a great deal of criticism, and it was for this reason that the ADTF called a meeting for the following day, at which an OMG member presented a suggestion on how to handle this issue. The suggestion was the on-going work of another RFP, consisting of a graphical representation based on a set of simple uncolored geometrical figures in a format that quickly became popular with FACESEM submitters.

On the following and final day of the meeting we received an offer from the ESSENCE team to join our respective submissions. If we had been told that this would happen before the entire OMG adventure started, we would not have hesitated to accept, but their offer was declined because of the favorable opinions that had been given regarding our proposal; KUALI-BEH thus continued as a separate effort, at least until the following deadline.

After the preliminary evaluation of the submissions had taken place, the ADTF stated that the revised submission deadline would be 13 August, 2012.

4.2. Revised submissions: a first approach and fusion

Back in Mexico, we continued working on KUALI-BEH and particularly on the three elements that the OMG evaluation team had identified as being strong:

- The method and practice concepts needed to express and structure ways of working in software engineering;
- The template-based approach, which focused on practitioners;
- The method properties defined to establish whether a method is well formed.

That was when the collaborative academy-industry workshop started, and a proof of concept was completed with promising results. During the workshop, KUALI-KAANS obtained invaluable feedback that served as a foundation for the KUALI-BEH revised submission. A clearer definition of terms was constructed, an enactment description closer to reality was built and, more importantly, practitioners active in the IT industry found that KUALI-BEH was useful, as well as being easy to understand and apply. The workshop also permitted us to distribute our idea and spread the word about KUALI-BEH, which led to an increase in the number of supporter organizations for the revised submission, from 2 to 9.

On August 13, 2012, the new version of KUALI-BEH was sent to the OMG headquarters. On that occasion only two submissions, KUALI-BEH and ESSENCE, were received, while Softeam was in negotiations to become part of the ESSENCE submitters' team.

The communication between the submitter teams increased considerably at that point, in search of a joint submission by the end of the year. Both submissions were sent to each of the SEMAT chapters, with a request for opinions on how to manage a hypothetical fusion.

The first step was to create a conceptual mapping between the proposals, in order to corroborate the linguistic proximity between terms and definitions. The Latin American chapter used this mapping to generate a report [52] that highlighted:

- The importance of keeping the structure proposed in ESSENCE as the basic element of the kernel;
- The importance of keeping track of the states of both the methods and practices, as suggested by the KUALI-BEH proposal. We were also to recognize the significant work involved as regards defining the enactment states and the instance states; and
- The importance of concepts such as purpose, objective and measure, as well as knowledge and skills, as considered in KUALI-BEH;
- There was no agreement as to the definition of the concept of practice.

Finally, the report concluded that *"More than having similarities, both proposals seem to be complementary to each other"* [52]. Fig. 3 shows the mapping done by the SEMAT Latin America chapter, in which the yellow elements come from ESSENCE, the green elements come from KUALI-BEH, and the blue elements are the integrating elements needed to give final meaning to the pre-conceptual schema.

After the report was sent to other chapters, we received a visit from the SEMAT Latin American chair in Mexico, who facilitated

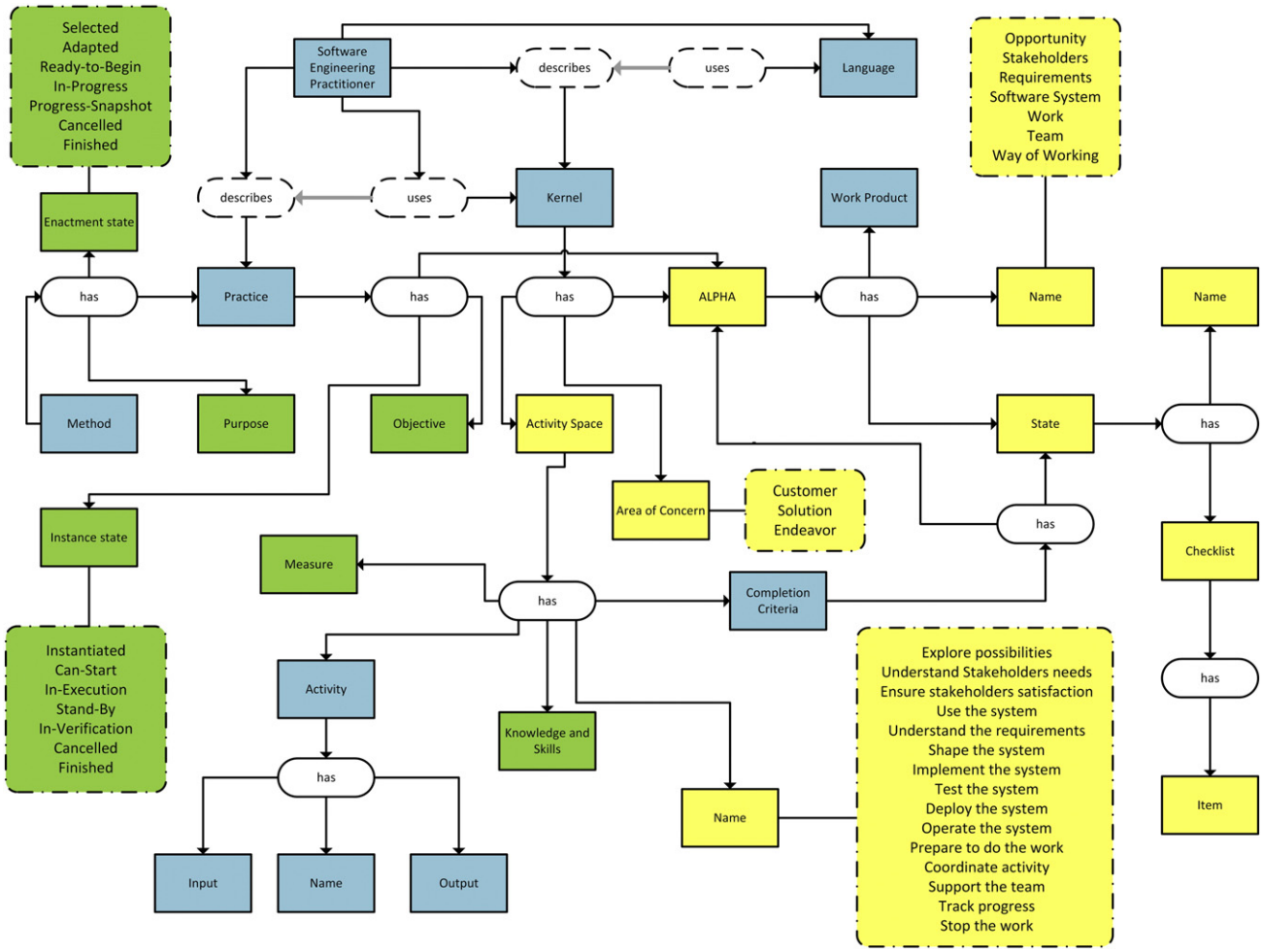

Fig. 3. Pre-conceptual-schema-based representation of the ESSENCE-BEH proposal, adapted from [52].

communication between the other chapters, China and South Africa, and with the ESSENCE team. The negotiations started with the objective of integrating KUALI-BEH into ESSENCE.

These negotiations led to the definition of a merger proposal, which can be summarized as follows:

- The KUALI-BEH practice concept must be a language construct with attributes, such as "objective";
- ALPHAs must be considered as practice inputs and outputs;
- The ESSENCE completion criteria concepts must include criteria related to work products and/or conditions;
- The KUALI-BEH measure concept must be included as a language construct;
- The KUALI-BEH method concept must be a language construct with attributes such as "purpose";
- The method must have a procedure to evaluate its properties of coherency, consistency and completeness; and
- KUALI-BEH views must be an extension of ESSENCE.

The negotiations ended a few hours before the following technical meeting started. That technical meeting was held in Jacksonville, FL, USA in September 2012. Both submitter teams had a meeting prior to the presentation session to seal the negotiations in person. On that occasion KUALI-KAANS sent only one person to represent KUALI-BEH, while ESSENCE had the full team in the room; these included Ivar Jacobson, whom the authors had met personally earlier that year in Reston when the first merger attempt did not come to pass.

After discussing each of the agreements and putting the final touches to it, KUALI-KAANS, Fujitsu, Ivar Jacobson International AB and Model Driven closed the deal and prepared a joint presentation. Until that moment, each team had its own presentation "just in case". The official presentation was developed, the announcement of the fusion made, and the ADTF set a fresh deadline of 12 November, 2012 for the joint submission.

4.3. Revised submission: the joint submission and voting

After the Jacksonville meeting, the major task was to carry out each of the agreements and produce the joint submission. With that in mind, the submitter team was divided into two working groups, one assigned to the kernel and the other to the language. Fortunately, the agreements had been described in detail and tightly scoped as a result of the previous negotiation, thus making the execution straightforward. For the task to be completed, it was necessary for meetings to take place every two weeks in order for the members to assign activities, report on status and monitor the progress of the joint submission.

The joint submission was sent before the November deadline, and on 7 December 2012, the technical meeting was held in Burlingame, CA, USA. There, the presentation describing the submission focused on how both proposals complemented each other and on how they had created a robust submission that still dealt with the mandatory requirements defined by the FACESEM RFP.

After the presentation, the submitter team had to respond to the comments and suggestions made by the evaluation team, and the subject of SPEM was again brought up, with IBM being its main supporter. The reasons given for not basing the submission on SPEM were presented; these convinced the evaluation team, but not IBM.

The submitter team then called for the Vote-to-Vote (V2V). The spirit of V2V voting is to obtain a consensus as to whether the submission is sufficiently mature; at least 75% of the members on the voting list wanted to proceed to the recommendation voting. 15 of the 24 OMG members who were registered as voters were present that day, and the V2V started. At the end of the voting, 75% of the 'yes' votes required had not been achieved, meaning that the ADTF had to request another checking cycle.

Right up until the deadline of February 2013, the submitter team received and responded to the comments from the evaluation team, and prepared the new version of the revised submission.

The following technical meeting took place in Reston, in March 2013. The revised submission was presented and the submitters responded to each of the evaluation team's issues. A V2V was again called and this time the required 75% of 'yes' votes was easily achieved. This made it possible for there to be a call for voting for recommendation, which was also passed with 85% of the 'yes' votes.

The ADTF recommended the proposed specification to the Architectural Board (AB), which endorsed the specification a day later. The submission then went to the Platform Technical Committee (PTC), at that time made up of 58 OMG platform members. The PTC voting is carried out online, in order to give all platform members the opportunity to vote. 41 members voted, with only 3 'no' votes, and the PTC voting thus passed.

The submission then went to the Business Committee (BC), the part of the Board of Directors (BoD) in charge of determining whether a submission is commercially viable and if implementation is imminent; a favorable opinion was obtained. After the BC evaluation passed, the last step was to wait for the BoD vote.

The BoD's announcement was eventually made; ESSENCE became an OMG BETA specification and its finalization process began.

4.4. Finalization

A Finalization Task Force (FTF) is responsible for drafting the changes that convert an adopted submission into a formal specification [51]. FACESEM FTF was chartered after the AB voted, but work started on it only after the BoD had voted. The first FTF working meeting was held in Berlin, Germany, on 18 June, 2013, where the BETA specification was made publicly available and the strategy needed to receive, analyze and respond to the proposed changes, suggestions and recommendations was defined.

FACESEM FTF comprised 9 members from 9 different organizations that included KUALI-KAANS, and the majority of the FTF members were non-submitters. The time limit for receiving issues was 9 December, 2013. In the meantime, any person or organization, OMG member or otherwise, could download the BETA version of the specification, review it and submit its issues to FTF using a form on the OMG webpage or sending the review by email. When an issue was received at the OMG, it was adapted and redirected to the FTF chair, who is in charge of coordinating the FTF tasks, its main task being to prepare the FTF report and draft the ALPHA specification.

Issues can be sent by FTF members, OMG members and non-OMG members, and an important source of issues is also the AB and the evaluation team. After the reception of issues had closed, the FTF members met at the technical meeting in Santa Clara, CA, USA, on 9 December, 2013. At that meeting the strategy needed to manage the issues was confirmed, and the software tool that makes it possible to view, sort, prioritize, give status, define its impact, propose solutions and assign tasks to FTF members was introduced. After using this tool, each of the registered issues was addressed.

The issues were prioritized, and a subset of issues was selected and assigned to particular FTF members. These FTF members were responsible for proposing a solution, but anybody could also propose one or more. The FTF discussed and defined solutions for the issues, and when a response had been obtained for everyone in the subset, a ballot was created and the FTF could vote as to whether or not the response to the issues would be applied, or if the voter could abstain. In order to consider a ballot valid, at least 5 of the 9 FTF members had to vote, and if a member did not vote in two ballots, then he or she had to leave the FTF, although this did not actually occur at this FTF.

The ballot box was opened three days later, and the issues that had been passed were applied. This process took place 4 times until all the

issues had been answered. The FTF report and the formal specification draft were then prepared.

Once the draft of the specification, in conjunction with the OMG Technical Editor, and the FTF report had been completed, both were submitted to the OMG Headquarters on 26 February, 2014. The four-week rule was then applied and the FTF presented their results to the AB during the Reston Meeting in March 2014, where the adoption of the specification was endorsed. The PTC later voted for its adoption; this was followed by the BC review and the culmination, which was the verdict of the BoD. This became ESSENCE 1.0, an OMG formal specification of which KUALI-BEH, after three years of hard work, forms a part.

4.5. Post-adoption

The ESSENCE standardization process will continue; it is currently in the revision phase, during which a Revision Task Force (RTF) is chartered, in charge of producing new minor revisions to existing, formally published specifications [51]. KUALI-KAANS is again part of the RTF. The RTF operated much as the FTF did with regard to collecting issues, resolving them and voting on the resolutions, culminating in the 1.1 version of ESSENCE.

The next step in this process will be to satisfy a Testing Task Force (TTF). The TTF supports the standardization of the test suites that will be used in certification programs [51]. Finally, the last step is the specification retirement; here a Request for Retirement (RFR) may be called to retire a formal specification from OMG adopted technologies. An action of this type would occur if an adopted specification were to be superseded, was never fully implemented, or had simply reached the end of its useful life [51].

Having taken part in the process, KUALI-KAANS has some suggestions that would improve the OMG standardization process: (i) the chairpersons in charge of presiding over the presentation sessions should not be part of any of the submitter teams involved in the session; (ii) the evaluation team should be explicitly named to the submitters and that team should identify itself clearly during presentations; (iii) the evaluation team should prepare and send an individual evaluation report of each submission to submitters; and (iv) in order to motivate and facilitate the participation of more universities in the OMG, membership costs and registration fees for universities should be reduced, taking into account the fact that they are non-profit organizations.

5. Lessons learned

Industry and academia are complementary *worlds of knowledge* that resist working together; it would appear that while both are interested in making a joint effort and that their objectives are very similar, achieving any real and effective collaboration is difficult. After three years of continuous and productive synergy, we can conclude that participating in this process has been a great and rewarding experience. The lessons learned during this period are described in the following subsections.

5.1. Lessons learned with respect to participation in the OMG process

The lessons learned in relation to the OMG standardization process and our participation in it are the following:

5.1.1. The OMG standardization process

As regard the rules and procedures of the OMG standardization process, we discovered the following shortcomings:

- The standardization process is agile, but not easy to understand and follow; as newcomers we had to study the process in depth and it was frequently necessary to seek clarification. It was difficult to understand who is evaluating the proposals, and we never received written feedback.
- The rules and purpose of the negotiation with other submitters are sometimes not clear. It took time to understand that one option was to give up our proposal and join another proposal as a support organization and that the other option, which we chose intuitively, was to integrate our proposal with another.
- The requirement of platform membership to participate in RFPs is an obstacle to the participation of universities in the OMG standardization process. Universities, if they are not especially focused on IT, are not interested in financing this kind of standardization effort.

Our suggestions to improve the process are:

- An *evaluation team* should be named, and formal *evaluation reports* should be produced for each submission. It would be very useful to have an extra meeting with the submitters during the technical meetings in order to discuss these reports.
- The evaluation team should *analyze and grade the conformance to the mandatory requirements* one by one, making its analysis available to all the voting members. It also should assure that the knowledge will not be lost and that the expertise of contributors is up to standard.
- A more “democratic” evaluation might be carried out, in an effort to discover and accept how each mandatory requirement has been addressed, thus allowing the *voting members to vote for each requirement and decide which of the proposals deals with it best*. This would also mean that a discussion on how to manage opposing ideas could be opened.
- The work between meetings should be monitored by an *OMG Control Force*, or by a web-based system like the FTF; this would allow all the issues contained in the evaluation reports to be correctly managed and tracked.
- An *OMG intermediary force* should be available to *guide negotiations between submitters*. Fostering the fusion of submissions is a noble OMG tradition, but there should be serious consideration that if no agreement is reached between submitters, this ought not to imply that one party will prevail.
- This intermediary force should also develop *conciliation tasks* based on the evaluation team's reports *regarding the equality between members*. In our experience, most of the OMG members are influential organizations in the IT sector and have power when a decision has to be made. Bearing in mind that not all members have this kind of clout, their proposals should not be considered less valuable or less significant.
- This intermediary force should also indicate how to join submitted proposals, indicating which aspects should be joined, mostly based on the voting.
- *V2V voting can slow down the process*, and in our experience in particular, the V2V stretched the process out over four months, without any apparent benefit.
- A mechanism to ensure that supporting organizations are really interested in the creation of the proposal, and that they truly support it not in words alone, should be put into place.
- The participation of universities should be encouraged by eliminating the requirement for platform membership.

5.1.2. The validation of proposals

OMG RFPs clearly state the need to demonstrate the usefulness of a proposal by showing a *proof of concept*, which must be presented from the initial submissions. But, how can the problem posed by having to validate something at a very early stage be handled? How can the skepticism of aspirant “guinea pigs” be assuaged? Moreover, are organizations interested in testing something that is not yet a standard?

To be specific, when somebody was interested in testing KUALI-BEH, a collaboration had to be planned, on the one hand because a training course on the proposal needed to be prepared, and on the other because the participating organization had to find a suitable project with which

to carry out the case study. Negotiations and agreements could take weeks or months when following these steps. As an alternative, we developed a collaborative workshop to which organizations and active software engineers were invited. During the workshop we trained these parties in KUALI-BEH, and they also had the chance to try out elements of KUALI-BEH part by part. At the end of the workshop the organizations then asked for a continuation, and we had the opportunity to carry out case studies with already trained participants.

5.1.3. The difficulty in obtaining funds

Being part of this project brought us much satisfaction and many successful experiences. However, there was always one obstacle that was difficult to overcome: getting funds. After sending the LOI to OMG headquarters and obtaining the university membership level, we were informed that as university members we cannot be submitters. This meant that we had to upgrade to platform level, which also implied covering a fee that was ten times bigger. With KUALI-BEH in its final stages and at risk of losing the research effort, we decided to pay the fee by asking for help from among the companies and people who appreciate our work in Mexico. For the second and third year fees, the university, realizing the magnitude of the project, covered half of the amount, while the rest was covered by donations from Mexican software developer organizations and people interested in KUALI-BEH. Dissemination of our project became essential during that time, so free webinars and invited talks were given, magazine articles published, radio interviews granted and letters to authorities written. Without the support of those organizations and individuals who donated to the cause, this project would not have been possible.

5.1.4. A highly demanding level of involvement

SEMAT's Call for Action addressed many ideas with which researchers we had an affinity as. We therefore tackled the initiative with a firmness and conviction that were reflected in the level of involvement we achieved. From the very beginning of the project we took it on as the most important project of the research group, attending each of the technical meetings and participating actively in all the working groups that came up during the process. As a consequence of this, we went from being newcomers to being members worth listening to.

5.2. Standard domain lessons learned

The lessons learned in relation to the standard and its domain are described below:

5.2.1. The wide variety of IT standards

During the development of the standard, we confirmed the existence of a wide variety of IT standards (supported by ISO, IEC, IEEE and also OMG) that lack an agreed-on definition of the terms used. This is not a recent phenomenon and dates back more than a decade [53]. According to [54], the terminology definitions vary significantly among the standards, even in those backed by the same standardization body. Moreover, the semantics of the terms can often be contradictory and misaligned, even within pairs of similarly focused standards.

Efforts to harmonize proposals and create ontologies have been made in an attempt to set right the deviation between definitions. In [55], a framework for supporting the harmonization of multiple models is presented, while the creation of a comprehensive set of definitions that conforms to standard domain ontology is suggested in [54].

Any standardization process therefore continuously deals with the challenge of unifying criteria, of creating homogeneous definitions and of harmonizing concepts. In the context of our standardization process these situations were handled in different ways; in our opinion, the most effective means of management is to ask a team of volunteers to deal with the issue, allow the team to present their solution, then reach a consensus and apply the solution. During the FTF the chair also prepared a ballot to vote for the resolution of issues, which improved the entire process and made it agile.

5.2.2. Inconsistent terminology

In the FACESEM process the issue that required more discussion than any other was the definition of the *practice* concept. The definition adopted takes into account different points of view mentioned during discussions, and if analyzed thoroughly it can be noticed that the *description* reflects the influence of ESSENCE, its *attributes* were based on KUALI-BEH, and the *semantics* of the term constitutes a mix of both approaches. Even so, during the FTF it was a controversial issue and now, at the RTF stages, it still is.

5.2.3. The shortcomings of ESSENCE

An issue that can be criticized in the standard is the treatment applied to the enactment of methods; to quote [17]: *"Dynamic semantics are partially defined"* or *"this function may be provided by a specialist tool"*. The reader may note that the solution provided is incomplete, leaving an important opportunity open for improvement. The KUALI-BEH operational view and KUALI-BEH extension provide the method-enactment and practice-instance alphas as an alternative in managing the enactment of methods.

5.2.4. The need for tools to facilitate the use of a standard in this domain

An OMG statement exists to the effect that before an OMG standard is officially adopted, the BoD must ensure that the submitter team will implement or use the specification in a product. This is a distinguishing constraint and an advantage, in comparison to other standardization bodies. KUALI-KAANS developed a tool, focused on practitioners, to create, modify and compose methods and practices. It is worth mentioning that the tool was developed by Master's degree students involved in the effort, and that this was a valuable experience for them.

5.3. Other lessons learned

The remaining lessons learned during this experience are:

5.3.1. The appreciation of standard-related work from the scientific world

Standardization processes require the consensus of industry and academics, and standardization signifies collecting accepted knowledge that enjoys a general consensus and that has proven to be effective in practice. To carry out this process, members of both parties should attend meetings, defend positions, hold discussions and make agreements that always focus on transforming ideas into proposals and finally into standards. As a whole, standardization implies a huge endeavor that can take up years of a researcher's work.

However, standardization efforts are not appreciated in research curricula, thus making noteworthy projects of this nature very difficult to find within the academic community. Compelled by the 'publish or perish' threat, members of the academia are far more inclined to attempt to publish papers, one after another, in recognized journals and conferences; they thus leave the important and fundamental task that is standardization to one side.

5.3.2. An academic background is not compulsory but it is advisable

An academic background is recommended and useful when discussing ideas and collaborating with the rest of the contributors to the standard. Particularly when the standard development includes several theoretical aspects, as is the case with FACESEM RFP influenced by SEMAT, an academic background is especially advisable and welcome. In our experience, the academic point of view fostered debates on ideas and motivated discussion. Although not all the academic ideas prevailed, we can assure that in every case they served as another means of enriching work sessions and, consequently, of improving the results obtained.

On the other hand, the academy needs to pay more attention to industry. Universities and educational institutions provide human resources ready to incorporate into industry and if the academics learn about industry's real and most important needs, they can better prepare future professionals by following more industry-oriented curricula. At the end of the day, industry and the academy are closely involved with each other.

5.3.3. OMG and ISO, not OMG vs. ISO

It was the OMG that supported SEMAT's Call for Action and gave it a formal process to support its development. However, having been part of the ISO and OMG, and having participated actively from beginning to end in the creation of standards in both organizations, it became natural for us to make comparisons between their processes. In our experience, the OMG process is more agile: while a standardization process in the OMG can take between two and three years, the ISO process is still seen as long and arduous. For example, it took 5 years until ISO/IEC 29110 was published.

On the other hand, the ISO is more participative and has a broader list of active members at its disposal. For academia, participation in the ISO is more appealing than taking part in the OMG. At this point we can observe that not allowing submissions from university members is an important obstacle; it hinders motivation and slows down any increase in academic participation in the OMG. Another difference is that in the OMG the heavy workload is distributed between meetings, while in the ISO that workload is concentrated into the actual meetings themselves. This could be a factor that affects the duration of both processes.

6. Conclusions and future work

SEMAT's phrase *"support a process to re-found software engineering based on a solid theory, proven principles and best practices"* [2] set out a common ground for the community involved in the discipline, which includes theory and pragmatics. The call attracted people from all around the globe who started to contribute to this quest. A mechanism with which to manage and control it was therefore needed. Thanks to the endorsement of this plan by the OMG, it became possible to establish a process to create an IT standard that dealt with the software engineering community's initiative.

Moreover, the significance of the SEMAT Call for Action, and later the FACESEM RFP, led to international collaboration. Researchers and practitioners, academics and industry worked together in the quest to create a standard that moved them closer to the goal.

In this paper we have presented how our research group responded, by creating KUALI-BEH, thus making an active contribution to the SEMAT initiative. Most importantly, it contributed to the OMG specification process when the proposal was integrated with ESSENCE and constituted as an improved standard.

Although the standardization process followed in the OMG proved to be strong and effective, it still has some room for improvement. We believe that the evaluation process for submissions could be enhanced by focusing on the individual analysis and assessment of each mandatory requirement defined in the RFPs, rather than by evaluating the submission as a whole. It is important for assessment reports containing the analysis results to be delivered to submitters so that they can improve their submissions. An intermediary force to manage fusions between submissions may also be of help; lastly, rules such as V2V could be avoided.

After living through this experience we have realized that there is a wide variety of standards that undertake similar aims. Nevertheless, they handle terms and definitions that differ in usage and meaning, thus making it difficult to unify criteria. ESSENCE is not the only work that seeks to homogenize concepts. We can also point to [12] and [54], which present very promising alternatives and results to consider when facing this challenge.

The academic community that is engaged in standards development should receive adequate recognition, since its activity is a valuable and fundamental task in building knowledge. In our experience, and as a lesson learned, there was an underestimation and unawareness of the implications of standards development, and we felt this ourselves. Academic institutions evaluate researchers in terms of number of papers, but are reluctant to consider the development of standards as being an equally important effort.

The discussion must not focus on which is best, papers or standards; these are different types of work. The debate must rather focus on recognizing the real value and effort implied in the development of a standard. Not receiving proper recognition by institutions causes researchers to refuse to work in standardization, leading them to search out other paths and go in other directions. This means that when creating a standard, a valuable part of the knowledge may not be present during discussions.

Various lines for future work have been identified. On the one hand, KUALI-KAANS will continue with the formalization step of the KUALI-BEH project and finalize the construction of two software tools to make it more feasible for the framework to be used by practitioners and organizations. On the other hand, the research group will take advantage of its important background and experience working with VSEs and encouraging them to use and apply the standard created.

The post-adoption steps of the OMG standardization process will continue, moreover. Since KUALI-KAANS is still part of the RTF, it will continue to develop corresponding revision tasks, seek feedback from more organizations and improve the standard. We trust that this successful experience will serve as another example of how industrial-academic collaboration can obtain a valuable and relevant outcome for both parties. We hope to help to convince universities and organizations to start this kind of cooperation, or at least encourage them to consider it in the near future.

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