Actor mapping in digitalizing requirement pipeline

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Abstract:

Handling document-based requirements among operators, contractors and subcontractors in Engineering, Procurement and Construction (EPC) projects is so complex and cost ineffective. Industry actors seek to use digital technologies for exchanging requirements in a standardized way in order to make the process of requirement handling, cost effective. ISO 15926 is a terminology standard which is used by actors for unifying a way of describing technical information and ensuring consistent exchange of digital requirements. However, the information around how this standard works is inadequate. A descriptive historical case study is chosen as a research strategy in order to map the actors in ISO 15926 ecosystem by studying historical documents as data generation method. The article contributes to the discussion of co-creation of standards by identifying different actors and illustrating how they react toward developing this standard.

Keywords: Digitalizing requirements, Standardization, ISO 15926

I. Introduction:

The Engineering, Procurement and Construction of new oil and gas facilities must comply with a wide range of requirements. Comprehensive requirements specification is much more than a list of functional requirements. It is a creative document which addresses the project needs, both functional and non-functional within the scales of quality attributes and performance expectations [1]. These requirements are based on standards from different standardization organizations (e.g. Norsok, ISO, etc.), governmental agencies, and industrial requirements along dimensions such as safety, reliability, environmental issues, etc. In EPC projects, large amounts of document-based and unstructured requirements pass through operators, contractors and sub-contractors. These requirements do not specify which information is for which actors and when should each be used through the project lifecycle. Therefore, consuming, managing and tracing them are so complex, time-consuming and cost ineffective which needs labor-intensive task works.

Digital technologies have made a significant change on organizational work processes, and industry actors try to use these technologies as a way to make the requirements handling more cost effective. It can also improve the efficiency of categorizing, prioritizing, managing, tracing and consuming the requirements. Through digitalization of requirements pipeline[1] for managing, propagating and consuming requirements, the goal is for actors along pipeline to transform their work practices in a more efficient way. Tilson (2010) argued that digitalization is a socio-technical process of digitizing technics that makes digital technologies infrastructural [2]. In this study, digitalization is about developing a system for propagating digital requirements on a

[1] A channel containing information regarding all the requirements for special project

standardized format. Standardization of digital requirements exchange is a large-scale sociotechnical change throughout the EPC project ecosystem therefore, considering not only the technical aspect but also the social one is vital [3].

This research is part of my PhD study which I should follow the process of digitalizing the requirements pipeline. The first step in following the process is to consider different actors and stakeholders, which motivates to focusing on ISO 15926 which is a terminology standard that the industry actors seek to use for ensuring consistent exchange of digital requirements. In other words, it efforts to develop a unified way of describing technical equipment which is perquisite for digitalizing requirements. Although this standard is used by industry actors, we don't know entirely about how ISO 15926 can work. Therefore, the questions that I want to answer by conduction this study are:

RQ1) Who are different actors in developing, maintaining and using ISO15926?

RQ2) How do actors interact in their ecosystems?

I investigated historical documents about this special standard to find the answers to these questions. The findings reported in this paper is part of an on-going effort to develop a better understanding of standardization challenges and how do actors react toward these challenges. The remainder of this paper is organized as follows. In section 2 the background literature is presented. Research method is described in section 3. Section 4 outlines the finding. Conclusion and future work can be found in section 5.

II. Background:

The origin of requirements management as a discipline is traceable from software/systems engineering industry. It has also been used extensively in other industries. The discipline is concerned with gathering requirements, organizing and analyzing this information, and managing the processes of reviewing and changing the requirements. These processes spread across the entire lifecycle of EPC projects with the aim of tracing the changes in requirements and investigating the influence of these changes on other stakeholders based on different aspects like time, costs and benefits and their schedule [4]. Although there are some studies that emphasize on having a system for requirements management [5, 6], Jallow et al. (2017) believe that there is no ad-hoc system to keep track of requirements through the different project phases within the construction industry [4]. According to industry actors' opinion, this is what can also apply to EPC project as well.

In order to having a system and handling the requirements digitally in EPC projects some level of standardization is required. Timmermans and Epstein (2010) believe that standardization allows the consistent coordination of people and things and creates specific kinds of mobility, uniformity, precision, objectivity and universality [7]. Timmermans and berg (2003) categorized standards in to four groups: design standards, performance standards, terminological standards and procedural standards. The first group, design standards are related to the structural specifications of social and technical systems which is used for integration and compatibility. The second category, performance standards, focus on the result of an action and represent outcome specifications. Terminological standards may insure high degree of semantic interoperability and they have been developed and used to ensure consistency of meaning across space and time, enabling large scale planning opportunities for local users. The last group of standards is related to the process of standardizing and establishing best practices and the steps that should be taken in special conditions [8]. All these four types of standards can be used when digitalizing the requirements

handling but the focus of this study is on the terminological standard.

Ellingsen et al. (2007) argue that the design and use of standards are co-constructed which means that standards are shaped by local work practice [9]. This also can be understood from what Timmermans and Berg (1997) stated, standardized work always involves local universalities. Standards should try to extend the routines beside changing and replacing current practice. it is expected that standards operate in an existing work practices, relations and infrastructures [10].

Standardization is a process of negotiation between technology and social aspects of its ecosystem and the interaction between standards and local practices [8, 11]. In other words, co-construction occurs when standardization and work practices constitute each other [9]. Therefore, it is impossible to consider standardization as a fixed characteristic of an object, it is a dynamic transformation of socio-technical network which is important for semantic interoperability. Many studies in the literature explain the importance of co-construction of standards and mention it as a required process for standards in order to function in practice [10]. However, there is no research illustrating co-creation and evaluation of standards. As Meum et.al (2013) argued studying standardization prompts questions such as how standardized terminologies are implemented and use in practice, how international standards and local perspective interact and finally how to approach such processes [12].

III. Methodology:

To address my research goals, I chose a descriptive historical case study as my research strategy and I conducted a study of development of ISO15926 over time as my case. The phenomenon that I investigated in this case was the evolution of this special ISO standard and the different actors involving in it. Document analysis is chosen as data generation method and qualitative methods is used for analyzing the data. The reason for choosing document analysis is that the aim of this study is to identify actors developing, maintaining and using this special standard. Bowen (2009) believes that documents can provide data on the context within which research participants operate. Such information can help researchers understand their historical root of specific issue and can indicate the conditions that influence the phenomena currently under investigation [13].

Case:

ISO 15926 is an international standard with the title of "Industrial automation systems and integration - integration of the lifecycle data for process plants, including oil and gas facilities." ISO 15926 is divided to a number of parts. Overview and fundamental principles are defined in ISO 15926 Part 1[14] and is a representation of information associated with engineering, construction and operation of process plants. The representation of data is specified by a conceptual data model that can be used for technical information about the process plants [15]. This data model is known as ISO15926 Part 2 [16] and is designed to be used with special reference data which is the definition of terms that represent information common to industry. This reference data standardized by ISO is specified as ISO 15926 Part 4 [17]. ISO 15926 Part 3 is defined reference data for geometry and topology. ISO 15926 Part 5 is about registration procedure which specifies the procedures to be followed for registration and maintenance of reference data and ISO 15926 Part 6 defines the scope and information required when defining additions to ISO 15926 reference data library. However, it is difficult to define an application-specific information model to represent plant lifecycle data and to develop its applications with the use of ISO 15926 Parts 2 and 4. ISO 15926 Part 7-10

are developed to solve this problem and provide implementation methods for the integration of distributed system. ISO 15926 Part 7 [18] specifies templates that are expressions of predefined semantics, allowing the use of Part 2 in convenient way. ISO 15926 Part 8 [19] defines information requirements for the representation of ISO 15926-based plant data in Web ontology language (OWL). ISO 15926 Part 9 specifies the implementation method for a triple data repository called façade, which stores ISO 15926-based plant data. ISO 15926 Part 10 defines an abstract test method.

Data collection:

The data for this research is gathered through internet search by focusing on finding any useful (electronical) documents like reports, website's information, etc. to use them as a vessel of content about ISO 15926. I investigated founded documents by doing snowball sampling where studying about history of ISO 15926 recruit studying further subjects about different actors. In order to justify the appropriateness of documents found on internet, content analysis is done by considering actors and events.

The reason for using historical data is that each standard has its own history, and it is the specificity of that history that makes the standard a compelling topic of social analysis. These standards originate as plausible solutions to unique historical contingencies. It is only embedded within this historical context that a standard's creation can be appreciated as being remarkably innovative or surprisingly conservative. A key issue in studying standard

creation is then to map the interactions among the multiple parties involved in the creation process, even paying attention to those that could reasonably be expected to be included but are currently not part of the creation process. The creation of standards can thus be thought of as the meeting of numerous parties with the aim of obtaining legitimate coordination, comparability, and compatibility across contexts [7].

IV. Findings:

In this section, I explain my findings that I gained by studying development of ISO 15926 in order to understand who the actors are and how they react. The history of ISO 15926 is shown in Fig.1. According to this figure the consortium of EPISTLE has the most important role in developing this standard. Therefore, by considering this consortium and its members I try to find the actors that have a key role in developing ISO 15926 and then continue my research to find actors who are maintaining and using this special standard.

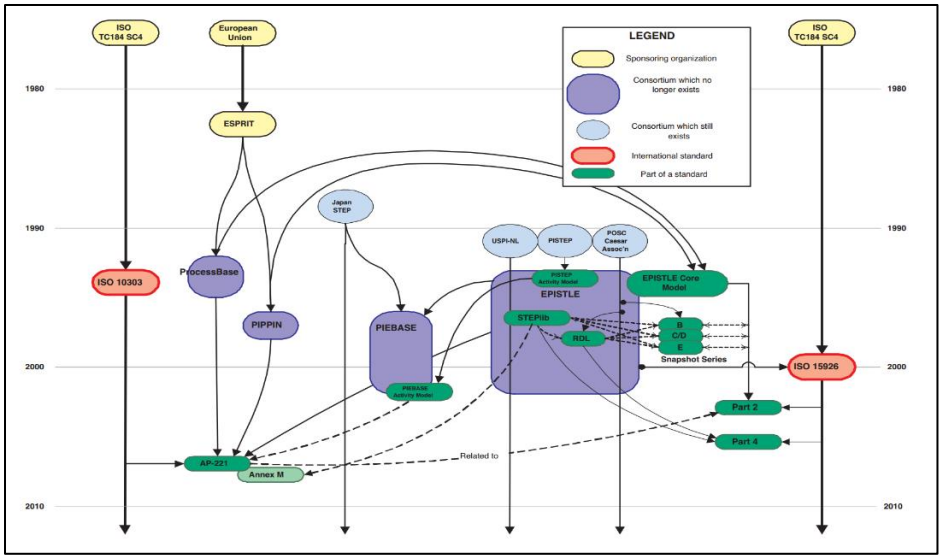

Figure 1: History of ISO 15926 [20]

EPISTLE was a forum that was founded in 1993 for all the international organizations and projects working toward standard-based exchange of engineering data[2] using STEP[3]standard. In early years of EPISTLE foundation there were numbers of companies as its member directly involved in plant design, equipment manufacturing and operations but over time the individual companies withdrew and only three consortia remained as its members that are USPI-NL, the Process Industries STEP Consortium (PISTEP) and Caesar Offshore Project which is now PCA. EPISTLE did some work on developing data models for exchanging data and managed the EPISTLE Core Model (ECM) [20].

USPI-NL is a Dutch process and power industry association which was created by an informal group of plant owners and EPC contractors that operated since 1997 under the name of SPI-NL. After four years they created the formal association USPI-NL in Nederland which supports ISO 15926 with emphasis on part 4 and its maintenance [20, 21].

PISTEP was founded in 1992 to increase the competitiveness of the UK process industry by improving engineering information management. Its founders saw that the current paper-based information-handling methods used during design, construction, operation, and eventual decommissioning was hampered by locking information in documents where it was difficult to find. PISTEP endorsed the use of international standards to store information so that it would be accessible across organizational and system boundaries and not be locked into proprietary systems. PISTEP merged with PCA in 2000.

The Caesar Offshore Project was founded in 1993 by seven organizations active in the North Sea as a research and development project under the name of Caesar Offshore Program. The purpose of the project was to develop a product model for life-cycle information. The focus was on standardizing the technical data definitions for facilities and equipment associated with onshore and offshore oil and gas production facilities. This program was sponsored by Research Council of Norway and two EPC contractors

[2] Documents such as drawing, manufacturers' specification, etc. related to design, procurement, test and inspection of item or structure

[3] Standard for the exchange of product model data

(Aker Maritime and Kværner), three owners/operators (Norsk Hydro, Saga Petroleum and Statoil) and DNV as service provider and project owner. During 1994-1996 Caesar Offshore Program was defined as a project of Petrotechnical Open Software Corporation (POSC) and change the name to the POSC Caesar Project. It was during this time that POSC Caesar become a member of EPISTLE.

POSC Caesar Association (PCA) was founded as an independent, global, non-profit, member organization in 1997 which collaborate with international organizations. Among all three members of EPISTLE, PCA had an important role in developing ISO 15926. It was found in 1997 to increase the development of open available standards for the integration and interoperability of data, software, and related matters for e-engineering and e-commerce. PCA has a special responsibility for the maintenance and enhancement of ISO 15926 [20, 22]. PCA has lots of members with strong membership in Norway including solution providers, academia, contractors and owners/operators. The list of its members can be seen in Fig 2.

Associations	Universities and Research Institute	Oil and Gas Company	Engineering Contractors and Consultant	Solution providers
• EPIM (Norway) • Norske Olie and gass (OLF, Norway) • Energistics (USA)	• International Research Institute of Stavanger (IRIS, Norway) • NTNU (Norway) • Korea Advanced Institute of Science and Technology (KAIST, Korea) • SINTEF (Norway) • University of Bergen (Norway) • University of Oslo (Norway) • University of Stavanger (Norway) • University of Tromsø (Norway) • Western Norway Research Institute (Norway)	• BP (UK) • Petronas • (Malaysia) • Statoil (Norway)	• Akvaplan-niva (Norway) • Aker Solutions (Norway) • Asset Life Cycle Information Management (ALCIM, Malaysia) • CAESAR systems (USA) • Bechtel (USA) • Det Norske Veritas (DNV,Norway) • Information Logic (USA) • IXIT Engineering Technology (Germany) • Phusion IM Ltd (UK)	• Aveva (UK) • Bentley Systems (USA) • Jotne EPM Technology (Norway) • Epsis (Norway), Eurostep (Sweden) • International Business Machines Corporation (IBM, USA) • Siemens - Comos Industry Solutions (before Innotec) (Germany) • Intergraph (USA) • Invenia (Norway) • Keel Solution (Denmark) • Noumenon (UK) • NRX (Canada) • Octaga (Norway) • Tektonisk (Norway)

Figure 2: PCA members [22]

Among PCA members, I continue my investigation by considering EPIM (Exploration and Production Information Management) which is a non-profit membership organization, founded in November 2007 and governed by the operators on the Norwegian Continental Shelf. The reason for choosing EPIM is that it has an important role in facilitating flow of information between operators, partners and stakeholders by cost effective service and solutions for collaboration within the oil and gas industry. Fig.3 shows different members of EPIM. Their main focus is to share information in a standardized way specially by considering ISO 15926. EPIM has different services like EnvironmentHub, EqHub, LogesticsHub, Licence2Share, etc. It also has an important project called Standardization Initiative which is for identifying unified requirements for information and documentation for each equipment type [23].

Figure 3. EPIM members [23]

V. Discussion

The purpose of this study was to contribute to the discussion of co-creation and development of standard by investigating the key actors and

stakeholders in developing, maintaining and using ISO 15926 which is terminology standards for unifying the way of describing technical equipment. Consistent with Timmermans and Berg's theory, the overall findings show that for designing, developing and consuming standards, dynamic transformation is required in both technical and social networks in ecosystem. It is obvious from the findings that the standards seek for the universality across settings and using terminological standard can ensure a shared and unique language used by actors when exchanging requirements data but according to the literature, they need to be sufficiently flexible for users of standards to align them to local needs. This can also be supported by the Meum el. al (2013) study that people only use standards to the extend they can integrate it with their work practices.

Empirically, the findings of this research are prerequisite for describing and understanding the context of digitalization of requirements pipeline in the service ecosystem. These information is needed for further steps of my PhD study. Identifying different actors and understanding how they react is required to be more centralized in investigating the challenges of standardization as well as digitalization in practice.

VI. Conclusion and Future work:

This study is conducted by investigating ISO 15926 standard which is exactly what industry actors need for exchanging digital requirements. By considering the historical documents, I mapped different actors in ISO 15926 ecosystem and explain how they react. I have emphasized on studying the development of ISO 15926, since I needed to know entirely about how this standard works to follow the process of digitalizing the requirement pipeline which is the aim of my PhD study.

By considering the theoretical perspective, standardization is a coordination mechanism which means that standards and local practices should constitute each other, and standards need to be sufficiently flexible for users of the standards to tailor them to their local needs. By having this tension between universality and local tailoring in mind, the next step is to investigate how do actors in developing systems for sharing digital requirements address this challenge. In other words, how do actors using ISO 15926 address this challenge and what did they do to cope with this problem. This is exactly what Meum et. al (2013) argued, we need to study how international standards and local perspective interact, when studying standardization. This can be analytically important and should be done in future research.

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