Digital Commissioning Processes for the Oil and Gas Sector

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Abstract

Oil and Gas (O&G) projects have complex engineering endeavours. A digital information management process is vital to increasing efficiency due to projects' size and complexity. The industrial plants' commissioning is regarding on-site testing to check performance and ensure final compliance of all equipment and systems installed. On-site commissioning procedures are mainly still managed by paper-work-based conventional methods. This work presents a digital solution' architecture developed based on an O&G company commissioning processes mapped. The novelty is assuring through a new integrator system agility and data traceability over digitalisation on-site commissioning procedures. Finally, the commissioning topic has limited scientific applied research, which this paper enhances future works.

Keywords –

O&G; Commissioning; Digitalisation; Processes

1 Introduction

South America has abundant deep-waters oil reserves [1]. Oil and Gas sector exploration projects have substantial budget investments, multiple interfaces, and complex engineering endeavours [2]. Due to the project's size and complexity, the management process is vital to increasing efficiency [2], [3]. The industrial plants commissioning is regarding on-site testing of all equipment and systems installed to check performance and ensure final compliance [4]. Therefore, the digitalisation of the commissioning activities will contribute to high-quality assurance providing digital data traceability [5] increasing performance [6].

Commissioning on-site procedures of inspection and tests are mainly still managed by paper-work-based conventional methods [7], [8]. Lacking interoperability and the information post record over software systems are persisting issues that inhibit digital process-oriented management [6] making the processes prone to errors [9]. The IFC (Industry Foundation Classes) is a neutral and open data format standardised by the ISO 16739-1 and used for modelling activities and attributes related to an engineering project [10]. Although the use of IFC has increased over time, this format is not widespread in the O&G sector. As a result, there are no IFC applications for facility commissioning information management.

To face this challenge, CERTI Foundation, a Centre of Reference in Innovative Technologies and an O&G (Oil and Gas) Company from South America, started an innovation project to develop a digital solution to deploy commissioning on-site with the integration of existing systems and new mobile applications. The project aims to develop an application interface that can implement inspections and tests commissioning procedures customised by managers to be deployed on-site where the workforce can receive and record the execution of the tasks in near real-time.

This work presents the digital solution' architecture developed based on the commissioning processes mapped. An IDM (Information Delivery Manual) [11] is performed to capture the current business process (as is) integrating all stakeholders. The identification of the status quo allows the understanding of detailed commissioning specifications concerning stakeholders, processes, systems and information. After, together with the O&G commissioning management team a "as to be" process is developed setting the new system requirements. Finally, the novelty is regarding assuring through a new integrator system agility and data traceability over the digitalisation of manual paper-based on-site commissioning procedures. It should be highlighted that the topic has limited scientific applied research, and this research contributes to enhancing future works.

2 Commissioning procedures in the O&G sector

2.1 Background

Once O&G projects assembly is consolidated, and before plant operations, a detailed commissioning process is mandatory [12]. The commissioning process guarantees that the assets will be delivered to users in complete conditions, with all tests and preservation carried out and updated documentation [13]. The commissioning phase is time-consuming and can be associated with health, safety and environmental (HSE) risks [12].

- The O&G company where the project is conducted uses three basic activities over the commissioning process.
- Commissionable tagged items – Any physical component previously identified with a vital function over the plant process.
- Preservation – This is a cyclical process of activities that aim to preserve the best conditions and functioning of the items that constitute the industrial plant.
- Systems Mesh verification – Interconnected set of commissionable items that compose a system mesh often concerning a plant piece of processing (e.g., gas injection system, cooling water system).

While for some authors, activities can be separated into pre-commissioning and commissioning, others consider commissioning a unique phase that falls within the pre-operation and construction phases [14], [15]. However, regardless of the project breakdown structure, the commissioning information management success is connected to integrating and managing information through systems and databases. Most importantly, the software communication is integrated into different languages and needs a fully integrated data exchange. However, software integration is often prone to error, lacking completion and low accuracy [9], demanding interoperable actions.

Poor data recording can significantly threaten project performance [15]. Information management is crucial for the O&G sector and directly impacts project quality assurance [16]. In a non-automated process, paper documentation assigned forms will directly prove that the procedure is done. The information generated during the commissioning process must harmonise and correspond to the project requirements [16]. Often, last moment documentation collection and preparation to deliver to clients impacts projects delay and claims [15]. Also, periodic reports are vital for the commissioning execution as the management team can exchange information about the project progress and identify areas of concern [15]. Therefore, it is essential to use a system that allows the management of documents that lead the procedures involved in the project. Furthermore, a commissioning system should fully visualise the processes and enable communication between those involved.

2.2 As is commissioning procedures

The O&G commissioning process studied is currently performed in a database software system that creates PDF files to orient on-site activities. The actual database system works with a fixed process, which means that the process has to happen as designed in the first version of the system. It is not allowed to update, change or customise the activities. Most importantly, all the on-site procedures are performed based on printed paper forms. As activities performed on-site are later recorded on the system by human input. The following steps performed by the specific actors are conducted for commissionable items and system mesh verifications:

- Managers: Login the system, input information regarding commissionable items and systems mesh and release the commissioning procedures (items verifications, mechanical inspections and functional tests).
- System Operators: Print the technical inspection procedures and send them to the on-site workers.
- On-site workers: Receives the paper forms with the technical inspection activities, performs them, fills the paper forms with the execution information, and sends the paper to the system operators.
- System Operators: Record the activities information to the system and send the paper forms for approval.
- Managers: Fill out the paper forms with the process approval and send the papers back to the system operators.
- System Operators: Record the approval information on the system.

The preservation is a cyclical and parallel process and is over just when all the commissioning process is completed, it follows the steps below:

- Managers: Login in the system and input information regarding preservation procedures.
- System Operators: Input the information that will release the preservation procedures. Print labels with the procedures and place them in the respective items on-site.
- On-site workers: Find the items with the labels, perform the procedure and fill the paper with the activities information.
- System Operators: Go on-site to collect the items' execution information, record them in the system,

send them to approve and send an email to inform the managers about the approval process.
- Managers: Approve the preservation procedure in the system.

2.3 As to be commissioning procedures

As identified, the main bottleneck was related to manual commissioning activities, instructions, and reports. Based on that, the new process designed targets eliminate all paper-related steps. Deploying the commissioning procedures for digitalisation using a process-oriented architecture increases users' usability by providing a tailor-made tool. That concept will increase quality assurance where the company engineering team is now in charge of modelling the procedure flows and checking the field procedures execution.

As the process is dynamic, it is possible to add as many approval steps as they want to assure that the right information is uploaded. So, if one activity is refused, it will return to the field worker with the appropriate guidelines for correction. And until the evaluator does not approve, the activity does not follow the flow. The new processes facilitated and eliminated users' work. The following steps demonstrate the new process:

- Managers: To log in to the web application to design a commissioning procedure using standardised processes or model new ones.
- On-site workers: To log in to the mobile application and identify the procedures to be conducted. To perform and report the activities execution concerning the items verification, system mesh verification and preservation.
- Managers: Receive the procedures completion alerts and directly in mobile or web applications perform the approval or not.

With the new flow, there is no longer a need for a dedicated System Operator as Managers can quickly check the data uploaded and executed activities. In addition, the managers can adapt the workflow of the procedure through the system to satisfy the new demands. The software will have embedded continuous improvement since it is possible to analyse the new workflows designed and implement improvements over the procedures.

The system interoperability will be made over Industry Foundation Classes (IFC) to assure accuracy in data exchange when necessary and improve the transparency in the process. An IFC commissioning schema was developed and published in an open repository (doi.org/10.5281/zenodo.5786902) where different vendors can access [17]. The IFC commissioning standard in IFC JSON was validated by the buildingSMART converter [17] .

Thereby, the commissioning process developed will have significant improvements, such as:

- Significantly lead-time reduction.
- Data consistency and traceability in near real-time.
- Workforce reallocation to functions that add value to the process.

Figure 1 shows the system use case diagram that helps to describe the relationship between the system, actors, and case uses. The managers (primary actors) can use the web system for configuration, customisation, and validation of the commissioning procedures. The on-site workers (secondary actors) will utilise the mobile to receive the procedures and record the work done.

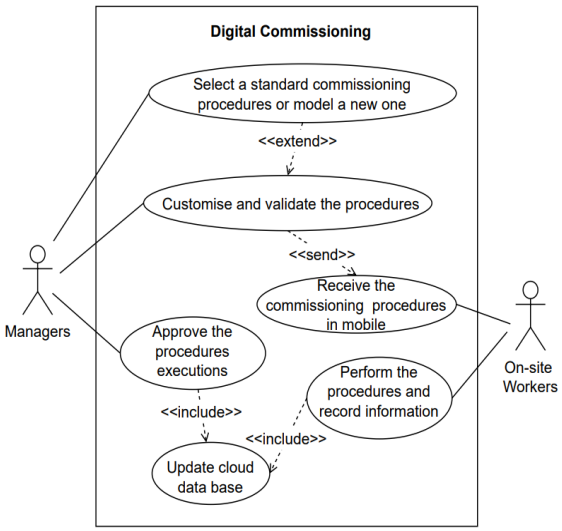

Figure 1. Digital commissioning use case diagram

Figure 2 presents the architecture systems concept. The Digital Commissioning system is a web and mobile application with the same interface, making a two-factor authentication by the ADFS (Active Directory Federation Service).

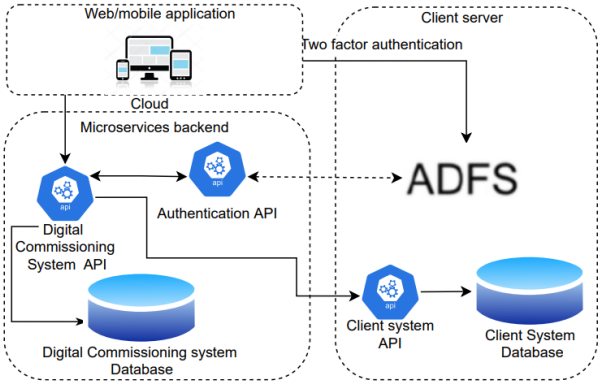

Figure 2. Digital commissioning architecture system concept

The ADFS service enables a secure sharing of identifying information through the client system to call the service backend by an authentication token. The backend is based on microservices in a cloud computing server. It stores the data in an internal database (Digital Commissioning database) while calling the client system API to synchronise the same data in the client system database.

2.4 Remarks and Future Directions

This work summary presents a system that brings a digital solution that automates the commissioning process. The digital management of the information directly affects procedures performance evidence. When the digital solution is fully implemented, the commissioning process will be done quickly, increasing quality assurance and eliminating non-value activities. Finally, bringing easiness to workers' routine with digital data traceability. This work is limited to presenting the commissioning flows only considering the procedures on-site. In future research, this digital solution will add IoT (Internet of Things) and integrated Building Information Modelling (BIM) to develop mixed-reality tools for on-site workers.

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