Information management for decommissioning of Oil & Gas facilities

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Abstract:
The availability of accurate and reliable data is essential throughout the various life cycle stages of the development of Oil & Gas facilities. However, there are currently many challenges in information management of Oil & Gas projects which hinder the availability of quality data. Inadequate data management practices have a negative impact on the various project life cycle phases leading to delays and litigation between project partners. Due to the nature of Oil & Gas projects, involving many contractors and subcontractors, structured information management processes are essential to enable a smooth transition between the development, commissioning, handover, production, and decommissioning life cycle stages. Standards and specifications such as ISO 15926 and the Capital Facilities Information Handover Specification for process industries (CFIHOS) have been developed to address these challenges, enabling the standardisation of data requirements throughout the life cycle of these facilities. However, due to their complexity, and the industry's current business processes, their adoption has been limited and the industry remains fragmented. The lack of standardisation constitutes a major obstacle for the management of the late life stages of Oil and Gas facilities. In this paper we propose a framework for the development of decommissioning programmes of Oil & Gas facilities, based on existing guidelines from the Department for Business, Energy and Industrial Strategy (BEIS) and the Oil and Gas Authority (OGA) in the UK. The framework proposes the integration of a variety of visual data sources and GIS with asset data and documents structured according to the CFIHOS standard. We investigate the applicability of reality capture and visualisation methodologies for the planning of decommissioning procedures. This is accomplished through the integration of 360º photography-based walkthroughs with an existing Engineering Project Management (EPM) solution, which is currently being used by Oil and Gas facility Owner/Operators.
Results from this research form the basis for the development of a dedicated software solution to manage the late life of Oil and Gas facilities, which will enable Owner/Operators to maximise the use of their facilities and to plan the decommissioning process in a safe and cost effective manner according to the UK regulations.

Keywords: Oil & Gas facilities, Decommissioning, CFIHOS, ISO 15926, GIS, Reality Capture

1. INTRODUCTION

Information management for Oil and Gas facilities has been the focus of research for a number of years. Various engineering data management standards and specifications have been proposed to streamline the access and delivery of data throughout the lifecycle of Oil & Gas assets (Kim et al., 2011; USPI-NL, 2011; Rasys et al., 2012; Fiatech, 2017a; Fiatech, 2017b).

The ISO 15926 standard provides a Reference Data Library (RDL) to enable the integration, sharing, exchange, and handover of data about process industry assets, including Oil & Gas assets, between disparate computer systems (ISO, 2004). Several projects based on this standard are currently under development to enable its adoption by the Oil & Gas industry (USPI-NL, 2011; Fiatech, 2017a; Fiatech, 2017b).

The Capital Facilities Information Handover Specification (CFIHOS) is an ongoing industry effort that will provide a practical implementation of the ISO 15926 standard. CFIHOS proposes the definition of several information management specification templates to support the whole lifecycle of process plants, including the specification of a Reference Data Library, which defines the required documentation at each phase of the assets' lifecycle (USPI-NL, 2011).

Fiatech has developed guides as well as various tools for the implementation of the ISO 15926 standard by the Oil & Gas industry, including the development of information patterns for ISO 15926 to enable standardised information access and data exchange between software applications (Fiatech, 2017a; Fiatech, 2017b).

The International Association of Oil & Gas Producers (IOGP) is coordinating the implementation of ISO standards by Oil and Gas companies, through the definition of a series of templates which take into account additional Owner/Operator requirements, through the development of the JIP33 initiative (IOGP, 2018).

It was expected that these standards would be adopted by the industry, enabling facility life cycle management (Figure 1). However, due to their complexity, and the industry's current business processes, their adoption has been limited and the industry remains fragmented. For existing facilities coming out of commission, data is typically unstructured, unreliable and incomplete, which introduces significant challenges for the planning and development of decommissioning programmes.

In the UK, increased attention has focused on the decommissioning of Oil and Gas facilities. Government institutions such as Business, Energy and Industrial Strategy (BEIS) and the Oil and Gas Authority (OGA) provide a variety of guidelines to ensure that owners decommission their facilities according to the international regulations (OSPAR, 1998). The current decommissioning process across the North Sea involves extensive planning and consultation with regulators several years before cease of production (CoP) (OGUK, 2017). This includes the selection of accredited shipyards to decommission the facilities (ISO, 2009). In the UK, decommissioning activities are partially publicly funded through tax relief (HM Treasury, 2012), so there is a strong focus in minimising costs and environmental impact, while facility owners are focused in maximising the production capacity of their facilities during the late stages of their lifecycle. Decommissioning programmes for the United Kingdom Continental Shelf (UKCS), along with the corresponding environmental assessments, have to be approved by a government representative (Secretary of State), and are available for public consultation (OGA, 2018). Various standards and guidelines have been proposed in recent years to support the decommissioning of Oil & Gas facilities in the UKCS (BEIS, 2017; OGUK 2015; HIE, 2017; OGUK, 2017).

Key requirements for decommissioning include assets condition and an inventory of hazardous materials by asset. These requirements will inform the future use of the facility (i.e. reuse vs. recycle) and also provide key information for planning the actual decommissioning work.

This paper proposes the development of a framework for information management of Oil & Gas Decommissioning projects. The framework considers existing decommissioning guidelines and proposes the integration of various visualisation methods with an Engineering Project Management (EPM) solution. Visualisation can provide an important role in the decommissioning of Oil and Gas facilities since it can provide input to inventory mapping and condition assessment, reducing the time and expenses associated with offshore trips. The framework proposes the use of Geographic Information Systems (GIS) to plan offshore operations, the use of reality capture methods for preliminary assessment of facility topsides condition, and the development of 3D models of subsea assets, to support the decommissioning of wells and pipelines. Documents management is provided by an in-house proprietary EPM software solution. Two case studies were carried out focusing on the development of 360º photography-based walkthroughs of the topsides of Oil and Gas platforms, which are linked to underlying asset data in the EPM system. The resulting walkthroughs can be used for the early stages of topside decommissioning planning, reducing costs and risk associated with time spent offshore.

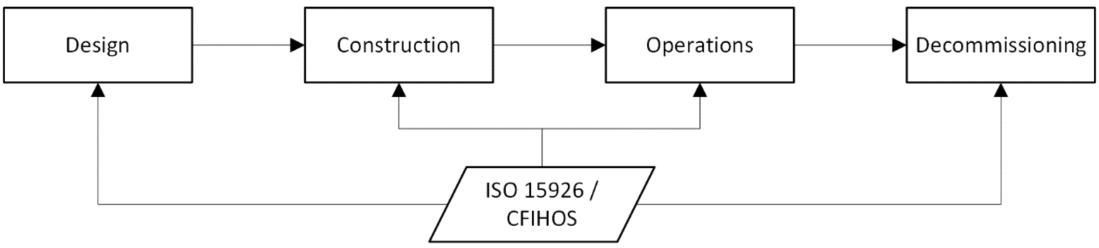

Figure 1. Lifecycle of Oil and Gas facilities supported by the use of standards

2. PROPOSED FRAMEWORK

2.1 Decommissioning Framework

One of the primary industry requirements for decommissioning is the reduction of time spent offshore, both for safety and economic reasons. Decommissioning of Oil and Gas platforms is typically executed in a modular fashion, where different facility modules are decommissioned throughout an extended period of several years, depending on the facility operator’s needs.

In this research, a framework is proposed to streamline the planning of decommissioning processes, which is expected to reduce the time spent offshore and provide accurate data to enable decisions regarding the fate of the assets. The proposed framework will be used as a basis for the development of a central repository of information for decommissioning projects, including cost control, execution scheduling, capacity planning and also track the actual results of the execution.

Oil and Gas facilities can be split into Topsides, and Subsea infrastructure (including wells, pipelines and other assets). The decommissioning process of Oil and Gas platforms starts with the decommissioning of individual assets in platform topsides, followed by the decommissioning of systems, and eventually the whole platform. Before platforms can be decommissioned, they must be hydrocarbon-free. After systems have been decommissioned, the topsides are prepared for removal, which involves separating them from the process and utilities modules and the installation of lift points. The preparation of topsides and substructure for removal depends on the removal method: piece-small, reverse installation (piece-large) or single-lift (OGUK, 2017).

- The piece-small method consists in dismantling the topsides and using demolition to produce small, manageable pieces that can be transported to shore.
- For reverse installation or piece-large, the topside modules are lifted separately onto a transportation barge or the deck of a crane vessel before being taken to shore.
- The single-lift method consists in removing topsides in one piece. Extra engineering work is typically needed to reinforce them in preparation for removal.

Depending on the facility and decommissioning method, some systems will need to remain active during the decommissioning process.

Subsea infrastructure includes wells, pipelines and other infrastructure assets. Well plugging and abandonment (P&A) consists in isolating reservoir fluids within the wellbore and from the surface or seabed. Well P&A constitutes the largest category of decommissioning activity in the oil and gas sector in the North Sea with 2,447 wells forecast to be plugged and abandoned until 2025 (OGUK, 2017).

Similarly to topside assets, pipelines must be depressurised and hydrocarbon-free prior to decommissioning. Pipelines are key assets part of a network for the transportation of hydrocarbons to end-users. Therefore, planning of pipeline decommissioning must ensure that major pipelines are not decommissioned prematurely. Alternatives for pipeline decommissioning include full removal, decommissioning in situ, trenching and burial. The decommissioning method is selected considering safety and environmental factors, technical feasibility, other users of the sea, and economic factors. For example, ageing pipelines can become a snagging hazard for fishing vessels (OGUK, 2017).

Data requirements for decommissioning come from different lifecycle stages, and can encompass the entire facility or part of the facilities, including a single installation or pipeline.
In accordance with the Petroleum Act of 1998 (OSPAR, 1998), Owner/Operators of offshore facilities in the UKCS must apply to the BEIS for approval to cease operation, decommission and removal of facilities. The application must take the form of a Decommissioning programme, which will detail the inventory of the facilities, the proposed method of disposal, and will also include a statement of how waste reduction will be achieved.

BEIS specifies a set of requirements for the definition of decommissioning programmes, including (BEIS, 2017):

- Identification of all the installed items;
- Description of the decommissioning solution;
- Specification of equipment that remains in place;
- Environmental appraisal.

In this research, we propose the definition of standard data templates to structure decommissioning requirements in a common format for the development of decommissioning programmes. The adoption of standard decommissioning work templates will reduce the need to re-work the same common procedures.

The adoption of visualisation methodologies can be used to plan decommissioning activities, and to evaluate assets and decide their fate (i.e. reuse or recycle). We propose the execution of laser scanning or 360º-based photographic surveys of Oil & Gas facility topsides for the development of interactive walkthroughs, linked to the underlying facility data provided by an EPM solution. This provides facility owners with the ability to identify and locate assets that can be reused, as well as assets that might contain hazardous materials from an early stage of the decommissioning planning process.

In this framework, visualisation is adopted for the Topsides, through the use of reality capture methods (laser scanning or 360º panoramic photography surveys). We propose the development of 3D parametric models for subsea assets, which can be integrated with GIS data and used to evaluate pipeline decommissioning options and well P&A operations. 3D model visualisation can be integrated with the relevant data and documents about assets, provided that they have been structured in a common format, according to decommissioning requirements. An overview of the framework proposed in this research is provided in Figure 2. In the following section, the methods proposed for the capture and visualisation of Oil and Gas Topsides are detailed.

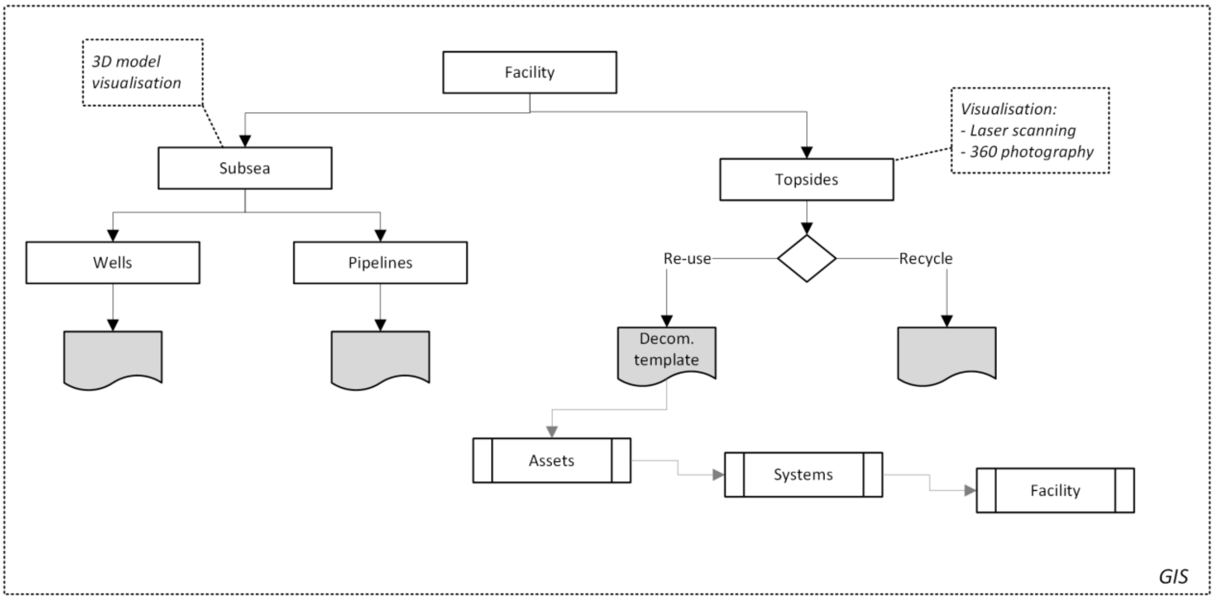

Figure 2. Framework for the decommissioning of Oil and Gas facilities

2.2 Data capturing and visualisation of platform topsides

The framework proposed in this study supports the development of reality capture methods for topsides of Oil and Gas platforms. A large number of Oil and Gas installations in the North Sea are coming to the end of their life and it is expected that over the next couple of decades many of these facilities will be taken out of service and decommissioned (USPI-NL, 2011). Given the age of these facilities, visual data in the form of 3D models and drawings is typically not available. Therefore, it is fundamental to investigate how reality capture methods can be used effectively to obtain a visual representation for these facilities and how they can be used to support removal operations within the decommissioning procedure. The use of reality capture methods can provide valuable inputs regarding assets' condition, and can also be used for the preliminary identification of hazardous materials, and to identify assets to be reused or recycled. Previous research efforts have explored the application of reality capture and visualisation methodologies in the Oil and Gas sector (Rasys et al. 2014; Hou et al. 2014; Wang et al. 2014). In this research, two main methods were considered to survey and develop walkthroughs of Oil & Gas facilities:

- Laser scanning surveys,
- Photographic surveys using 360º photographs.

Each of the methods can be used for the development of interactive walkthroughs to provide navigation of the facilities using a web browser to access a web-based EPM solution. Users can interact with existing assets and access their underlying data and documents. An overview of both methods is provided in Figure 3.

Previously, we explored and detailed the development of walkthroughs from a laser scanning surveys using game engines in a related research paper (Patacas et al., 2017). While the use of a laser scanner provides the highest quality of surveyed data, in practice it is not always possible to perform laser scanning surveys in Oil & Gas installations, due to transportation restrictions and safety reasons. 360º cameras, on the other hand, are affordable, extremely portable, and provide the opportunity to quickly capture existing spaces. If the device supports in-camera stitching (i.e. a feature in 360º cameras in which 360º panoramas are generated by the camera), post-processing time is greatly reduced. The resulting photographic surveys can be used for the development of walkthroughs in which specialised software tools (e.g. Panotour Pro) are used to link the different panoramas together. Photographic surveys can also be used for the development of 3D models using specialised photogrammetry software. Due to complexity of Oil and Gas assets, it is challenging to obtain accurate geometric features of the assets, however this process can be used to provide general spatial measurements of areas and rooms within the facilities.

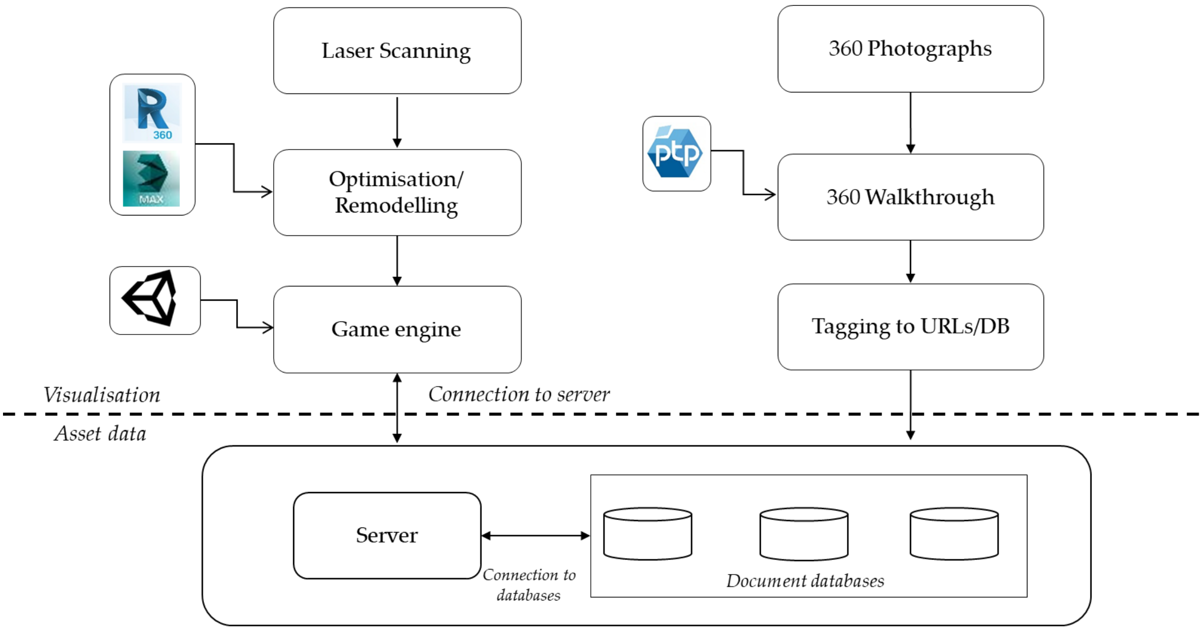

Figure 3. Workflow for the visualisation of Oil and Gas facility topsides with associated documentation data

3. CASE STUDIES

In this section we describe the process for the development of walkthroughs for topsides of Oil & Gas platforms using 360º panoramic photography. This methodology was applied to the survey of two platforms that are currently at the production stage:

- Normally Unmanned Installation (NUI) – Topsides: 1240 Tonnes
- Floating Production Vessel (FPV) – Topsides: 7853 Tonnes

Safety and transportation constraints were the drivers for the selection of the 360º panoramic photography survey method. Since both facilities are still in operation, the Operators only allow the use of Intrinsically Safe (IS) laser scanners for surveying the facilities. The only IS laser scanner available at the time of the survey was too heavy to be carried offshore due to restrictions in helicopter flights. Additionally, from our previous experience in surveying a small NUI with a laser scanner, it would not be feasible to capture the entirety of these facilities accurately with a laser scanner in such a limited time frame (Patacas et al., 2017). For these reasons, the Ricoh Theta S 360º camera was used to perform the surveys.

In order to maximise the available time offshore, the surveys were executed during one offshore trip for the NUI, and two offshore trips for the FPV. Initially, modules and critical assets were identified as part of survey planning. Each survey was performed sequentially by facility module, to save time in the development of the walkthroughs.

After the surveys were performed, walkthroughs were developed for each separate module in each facility, by linking the various 360º photographs from each module. For each facility, the corresponding walkthroughs are linked to a custom in-house EPM solution, which contains all the corresponding facility data and documents. Integration of walkthroughs is established at various levels, namely: Modules, Locations, and Tags. The relationship between these entities is summarised in Figure 4. Walkthroughs are embedded in the corresponding web pages, allowing the user to navigate the facility walkthrough from any of the EPM screens. URL links are established within the walkthroughs to link the various facility modules together, enabling the user to navigate the whole of the facility from any entry point. An overview of the methodology is provided in Figure 5. The users can interact with critical assets and retrieve the associated Tag data from the assets (Figure 6). An example of the Modules screen for the NUI facility is provided in Figure 7.

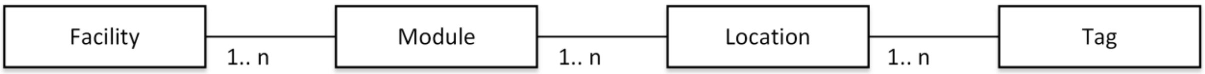

Figure 4. Overview of relations between Facility, Module, Location and Tag entities in the EPM system

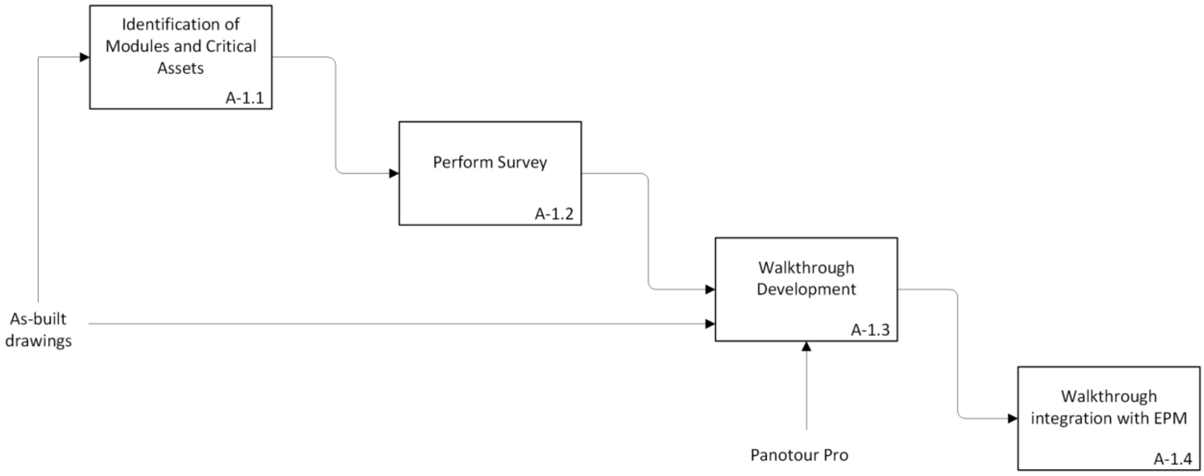

Figure 5. Methodology to link 360º photography-based walkthroughs with underlying asset data – IDEF0 diagram

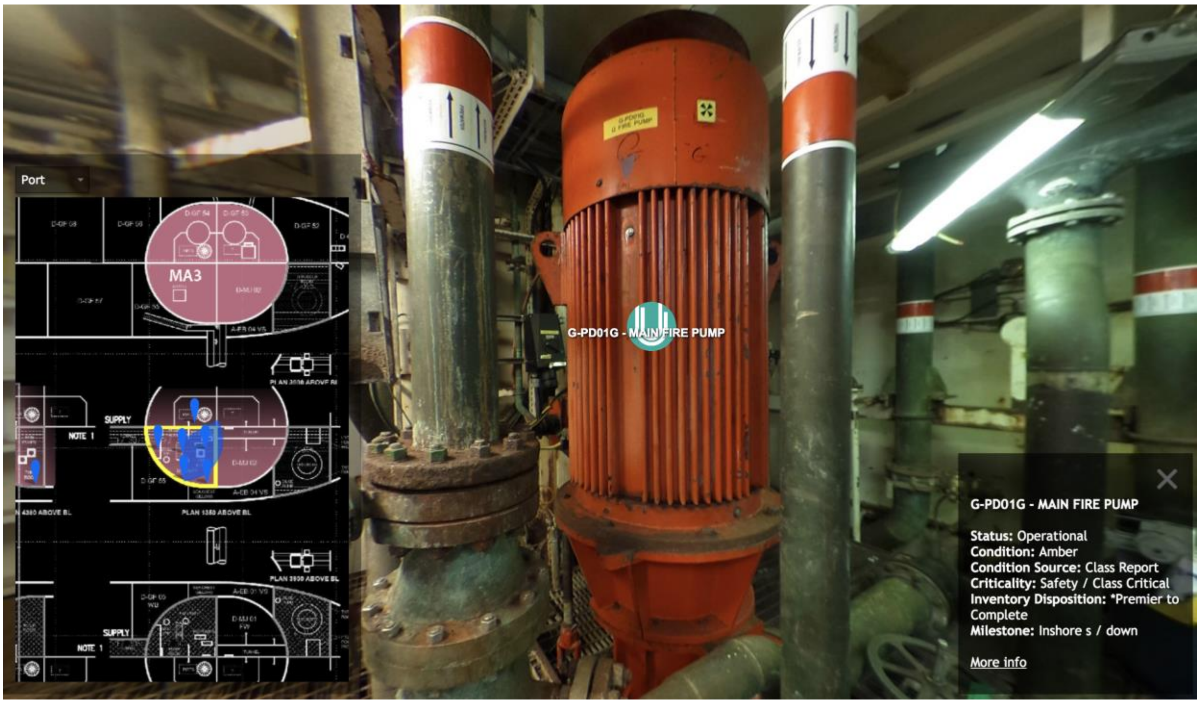

Figure 6. Visualisation of asset data within 360º photograph walkthrough

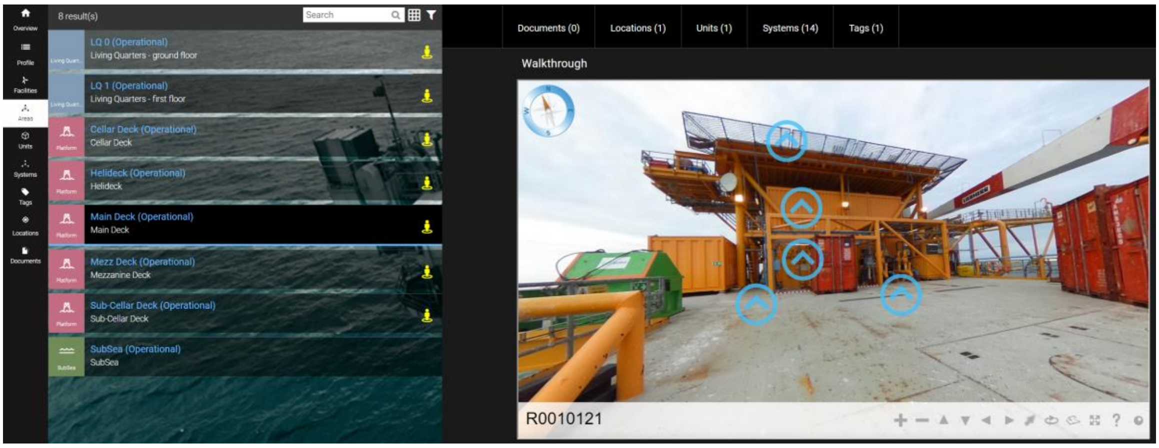

Figure 7. Integration of walkthrough with EPM software – accessing walkthrough from Modules screen

4. DISCUSSION

Results from the implementation of the 360º photography-based walkthroughs revealed a number of challenges related to the high number of photographs and links used within the software (Panotour Pro), however these can be overcome by further splitting facility Modules and establishing links between them. This method presents some disadvantages when compared to laser scanning surveys, which can be used to obtain accurate 3D models. The navigation experience is not as smooth, and it is not possible to measure assets or spaces. While it is possible to use specialised photogrammetry software to generate 3D models from photographs, this requires a large amount of photographs for each given space, and cannot provide asset measurements at the same level of detail as a laser scanning survey. This is particularly relevant for Oil & Gas facilities where the geometry of assets is typically more intricate than in a building. Nonetheless, the development of visual walkthroughs based on 360º photography allows for remote workers to evaluate installation conditions and make assessments on assets for supply chain capacity planning, maximise production during late life, and possibly even extending the life of platforms. During the operational stage of facilities, walkthroughs can also be used for training purposes and health and safety improvements. This enables personnel to be familiar with the offshore environment, improving work performance and reducing accidents.

Using the proposed 360º photography-based walkthrough development methodology, it was possible to integrate the surveys of two Oil and Gas facilities with their underlying asset and documentation data, using a custom EPM solution. Integration was achieved at the Module, Location and Tag levels. The method was successfully applied for the development of interactive walkthroughs for one large FPV and one small NUI.

5. CONCLUSIONS

In this paper, a framework was proposed for the development of decommissioning programmes for Oil and Gas facilities. The framework proposes the integration of various visual data sources with a custom EPM solution to provide Owner/Operators with detailed information on how to maximise the use of their oil and gas facilities during the late lifecycle stages and decommission the facilities safely and efficiently. The framework proposes the development of 3D parametric models for subsea assets to support the decommissioning processes of pipelines and wells, and the development of walkthroughs for the topsides of facilities by carrying out surveys using laser scanners or 360º panoramic cameras. The integration of GIS data is also highlighted as essential for planning the decommissioning procedures.

The paper focused on the development of walkthroughs based on 360º panoramic images and integration with an existing EPM solution. The proposed methodology was successfully applied to two existing facilities: one small NUI and one large FPV. The proposed methodology enables users to quickly access the required data for late life operations and planning of decommissioning procedures.

The framework proposed in this research constitutes the basis for the development of a dedicated EPM software solution to support the decommissioning of Oil and Gas facilities. This software tool will implement the CFIHOS standard and current established GIS tools to interface with Oil & Gas Owner/Operators.

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