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Challenges and Opportunities in Tags and Tag-related Technical Information Management Process in EPCIC and MMO Project: Mapping Industrial Practices and Evaluation of A tag Management Application

by

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Abstract

The fact that many giant Norwegian oil and gas fields are in decline, and that these fields have reached their tail phase urges Oil and Gas (O&G) companies to focus on maintenance and modification projects to extend the lifecycle of offshore fields and to enhance the production of these aging fields. All activities involved in Maintenance and Modification projects should be carried out efficiently to avoid shutdowns that would hinder production processes. Technical Information and data needed to accomplish small and large scale modification projects play a significant role in meeting projects' milestones and budgets.

Managing life Cycle Information (LCI) in EPCIC and MMO projects is considered to be one of the challenges in Oil and Gas Industry as it requires the integration of people, technology and processes to handle and control the flow of information among different parties involved. Companies might suffer delays if technical information and data are not available on the right time or in the required quality by different parties. Moreover, it is a must for Oil and Gas companies to comply with regulations and governing requirements and any poor coordination among parties in projects will affect this area and cause delays as well.

Tags and tag-related technical information management is an element of lifecycle information management in EPCIC and MMO projects. The way every element is managed, including Tag and tag-related technical information, reflects the strength of information integrity in the organization in general and in projects performed by the company.

Asset Integrity Department in Apply Sørco has developed and implemented a Tag Management System (Tag Manager) to handle tags and tag-related technical information in different phases of maintenance/modification and new construction projects for one of the drilling companies working on Norwegian Continental Shelf (NCS). This thesis aims to discuss the challenges related to managing tags and tag-related technical information in EPCIC and MMO projects. It will also discuss the capabilities of Tag Manager and its role in strengthening information integrity in projects performed by the drilling company.

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I consider it an honor to work with the Asset Integrity Team in Apply Sørco As. I especially thank Koroosh Ivali who has helped me conducting interviews that resulted in a great input to this thesis. Other colleagues who provided valuable advice are many to name here.

Last, but by no means least, my heartfelt thanks are due to my family for their constant encouragement and ever-unfailing kindness. I also would like to dedicate this thesis to my grandmother's memory; her unconditional love and care has allowed me to accomplish something I never dreamed would be possible.

Menyar D. Abu-shagfa

Stavanger, Norway

Sunday, June 15, 2014

Table of Contents

List of Figures

List of Tables

List of Abbreviations

ALM: Asset Lifecycle Management

EAM: Engineering Asset Management

EPC: Engineering, Procurement and Construction

EPCIC: Engineering, Procurement, Construction, Installation & Commissioning

LCI: Life Cycle Information

MMO: Maintenance, modifications and operations

O&M: Operations and Maintenance

NORSOK: Norsk Sokkels Konkuranseposisjon

NCS: Norwegian Continental Shelf

ISO: International Standards Organisation

PSA: Petroleum Safety Authority

RBM: Risk Based Maintenance

IT: Information Technology

Chapter 1 - Introduction

1.1   Background

Information is a very important part of life cycle management of any product, project or a system. It's a requirement for EPC contractors and other companies in oil and gas industry to have information management processes and tools including document management, change management, Tag and tag-related information management, and handover management, etc. These tools and processes are very important to support EPC contractors in running a successful business.

The elements of Asset Life Cycle Information Management are shown in the figure below

Asset Information Management –10 Essential Elements

Tag Management
- Mechanical Equipment
- Electrical Equipment
- Instruments
- Pipelines
- Specialty Items
- Mobile equipment

As-Build Management
- Define as-build criteria
- Define as-build tools
- Accumulate redline info
- Manage as-build projects
- Publish / Subscribe as-built info Management

Standards Compliance
- Manage design specification
- Manage technical STD
- Manage deviations from STD
- Perform STD compliance Audit
- Manage Non-Compliance Reports

Document Management
- Engineering Doc
- Vendor Doc
- Project Doc
- Operation Doc
- Maintenance Doc Physical

Management Of Changes
- Revision management
- Concurrent projects management
- Separate Plant Configuration vs Projects
- SAP Master Data reflects plant configuration

Handover & Turnover Management
- Provide accuracy content (as-built)
- Perform content audit (complete & consistent)
- Ready to populate equipment master

Physical Asset Management
- Equipment Master
- Manufacturer Names
- Model Number
- Maintenance Plan
- Maintenance History
- Bill of Materials

Native Files Management
- CAD Drawings
- Excel Datasheets
- Equipment Lists
- Appropriate access and viewing

Cross-Reference Management
- Tags-Documents-Physical Assets
- Information synchronization

Design Data Management
- 3D model data
- Intelligent data (INtools)
- SmartPlant tools
- AutoPlant tools
- Appropriate access and viewing

Every element is measured by its contribution to Information Integrity, Data Quality, Data Readiness and Regulations Compliance

Every single element should be supported by : People, Processes, Technologies and Information
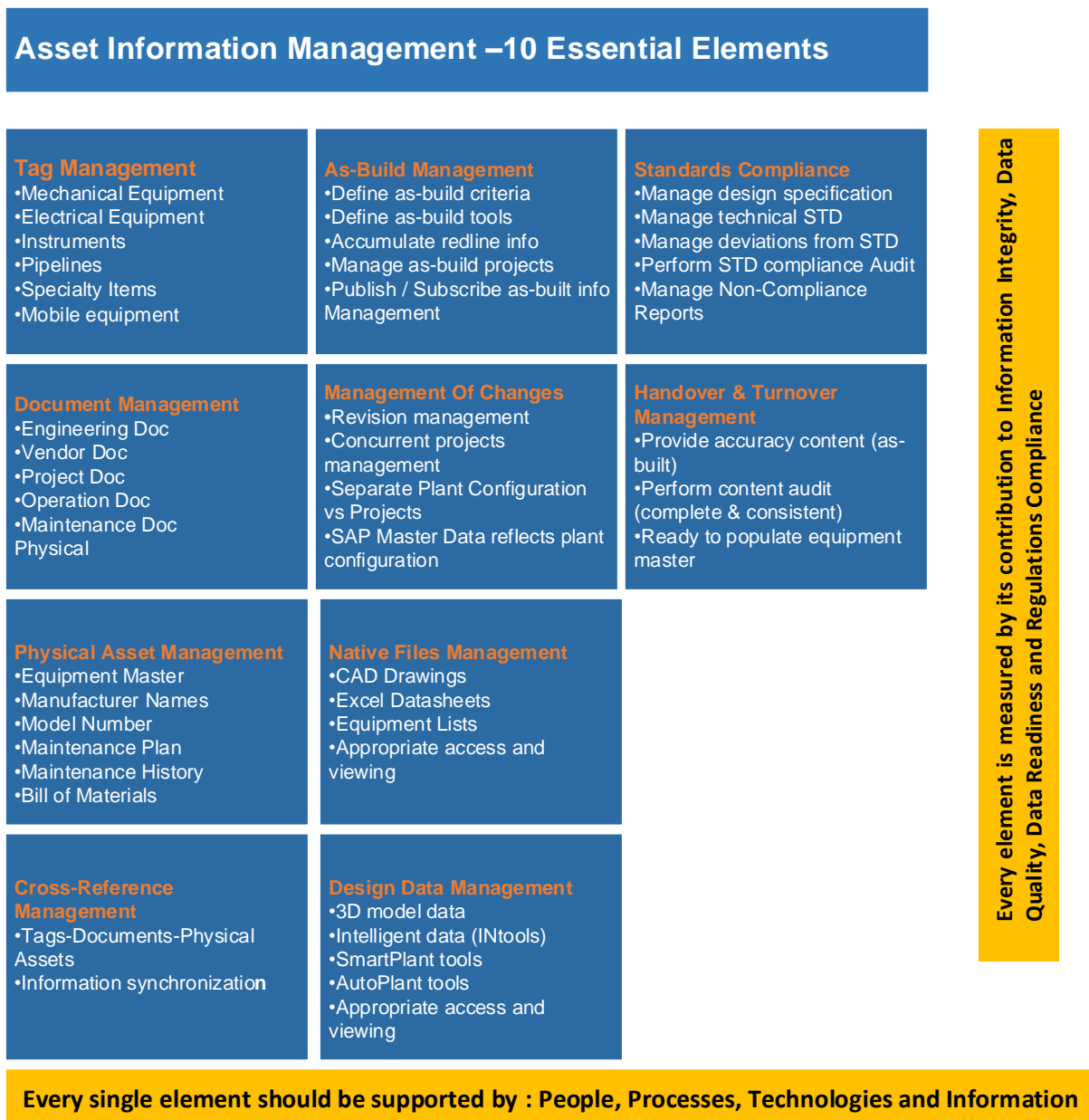
Figure 1-1: Asset Life Cycle Information Management Elements (Lau and Aksenchuk, 2011)

Information management processes and tools can also provide significance Life Cycle Management and Asset Life cycle Information benefits to EPC's clients and oil and gas companies.

Tag management is an important element of these elements and has its own processes and tools. Efficient management of Tags and tag related information in parallel with other elements has a great role in strengthen or weaken Information integrity during projects' developments.

Industrial Projects are made up of multi-parties where; this contributes to the confusion of ownership, e.g., who owns the tag repository. Engineering firms do not really benefits from keeping tag information clean and up to date; the owner does when he ingests Tag's information into maintenance system. The key beneficiary of tag usage accuracy is the owner not the engineering firms, therefore engineering firms and vendors do not keep appropriate track of tag usage. Keep tag track and follow all tags planned to be used in projects is a challenge and could cost engineering companies a lot of money due to complexity of this kind of work.

There are two different issues that should be addressed in Tag management, we should distinguish between engineering tag management and maintenance tag usage where functional location hierarchies are necessary to appropriately setting up preventive maintenance, studying failure codes, assigning maintenance integrity codes and collecting costs. On the other hand, engineering sees equipment for design purpose and uses and assigns hierarchies accordingly while maintenance sees equipment for maintenance purposes and uses hierarchies to isolate equipment, repair, maintain and analyse costs.

These are two different cultures and unless those who deliver tag management repositories for capital projects recognize this and address this complexity, the software to manage tags and the handover process will continue to address a mere part of the overall process. This will continue to frustrate information managers and those maintenance planners who are often left to solve the problem long after the contractor has demobilized and left the project.

1.2   Supply Chain Complexity in EPCIC and MMO Projects

Now that capital projects in the Oil & Gas industry are increasing in scope and complexity, global Supply Chain Management has become common. A Project's supply chain includes hundreds to thousands of vendors (and by vendors we take in account all sub-contractors and suppliers) from all over the world (valencyinc, 2014). Each of the vendors follows his own arrangement of processes and adopts different standards in the preparation of equipment and material information. Equipment parts may be manufactured in China, constructed in South Korea, and then integrated into sub-assemblies in Norway. Every supplier in the chain is challenged to meet strict project deadlines. Due to the absence of well-defined and well-understood contractual obligations on equipment and material information requirements, the owner, who comes last in the project lifecycle, faces many challenges including:

- The inconsistency of formats of equipment data submitted by different vendors-- everything from electronic PDFs, to native file formats, to paper-based documents.

- Late submissions– this directly impacts the deliverables schedule and might result in the suspension of several engineering practices that are mainly dependent on the information to complete detailed design.

- Design change or Quality issues – as gaps between engineering specifications and the final equipment delivered are not usually discovered before the installation.

- Incomplete submission of required data – if the owner could not resolve this issue before project handover, obtaining critical equipment data from venders becomes increasingly complicated and requires additional costs and labour (valencyinc, 2014).
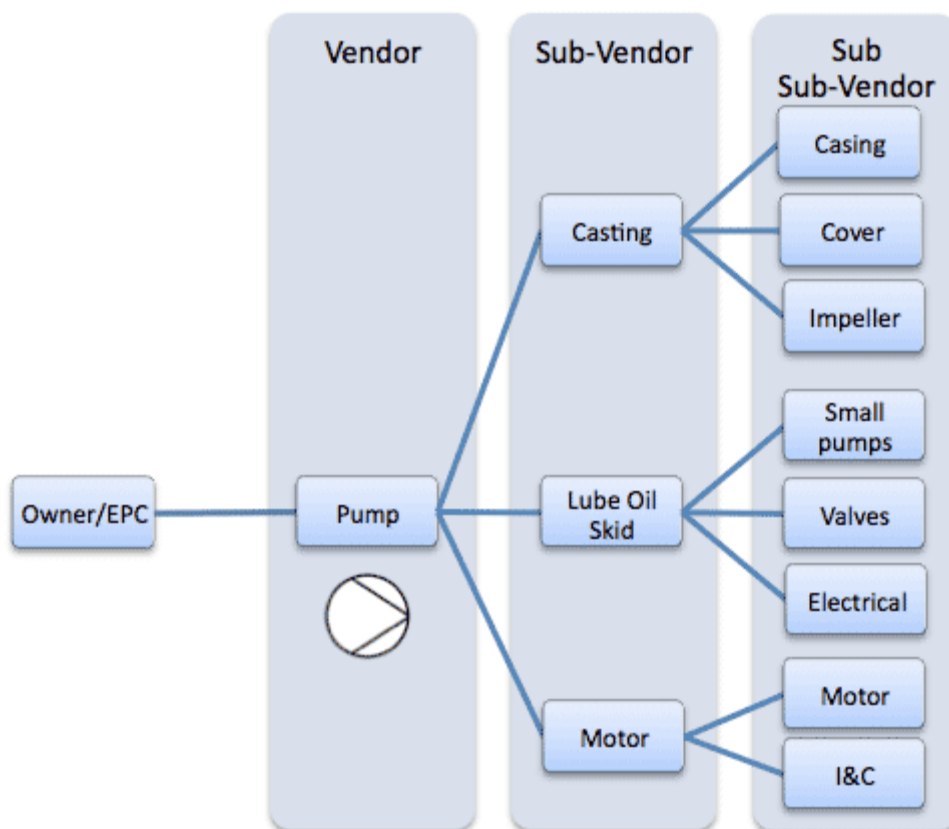
Figure 1-2: Supply Chain Example in EPCIC & MMO Projects (valencyinc, 2014)

1.3   Aim of the Thesis

The thesis will study tags and tag-related technical information challenges in small and large scale EPCIC and MMO projects as well in order to understand the current situation and best practices used to handle tags and tag-related technical information. Asset integrity Department at Apply Sørco has developed a tool to administrate tags and tag-related information in in small and large scale Maintenance Modification and Operations (MMO) and Engineering, Procurement, Construction, Installation and Commissioning (EPCIC) projects, (Tag Manager). Tag manager is in active use by a drilling company for more than one year. The thesis will map tag manager performance and identify the challenges and potential improvement areas that can enhance tag manager performance and capabilities.

1.4   Work Objectives

Research area will cover the next tasks:

- Mapping data and Life Cycle Information (LCI) Challenges in MMO and EPCIC projects.
- Covering the relevant standards and regulatory requirements.
- Mapping capabilities of tag manager in managing and administrating tags and tag-related technical information in project execution.
- Identifying the contribution of tag manager in improving information integrity, data quality and compliance to regulations.
- Identifying potential improvement areas to bring tag manager to its second phase if possible and in case Drilling Company requested this.

1.5   Limitations

The thesis is limited to tag management and the tool used to facilitate and enhance tag management during projects. There are many other elements related to Life Cycle Information management which will not be covered in this master thesis.

1.6   Methodology

The first chapters will go through the literature review related to life cycle information and tag management. A comprehensive survey will be prepared to map Tag manager performance. The input and performance indicators used in this survey are based on literature review and experience sharing with maintenance and project engineers.

The survey will approach five different areas and indicators to measure the performance of Tag manager. Information Integrity, data quality, regulation compliance, coast savings, and user interface have been chosen to be the main indicators used in the survey.

1.7   Report Structure

The Thesis flow and structure will be as followed:

- Chapter 2: Asset Engineering and maintenance issues will be reviewed briefly. Tag manager is a product developed by Asset Integrity Department and we can see that Tag manager is a tool based on asset engineering knowledge.

- Chapter 3: Asset Life Cycle information Management and Challenges in EPCIC and MMO projects will be discussed. Tag and tag-related information management is an element of life cycle information elements. This chapter will be the leading track to tag and tag-related management in EPCIC and MMO projects.

- Chapter 4: Norwegian regulations related to Life Cycle Information and Tag management in EPCIC and MMO will be reviewed.

- Chapter 5: TAG Management/TAG management Process in EPCIC & MMO Projects will be discussed. The challenges related to tag and tag-related technical information will be discussed to illustrate the importance of applications used to assist companies in this area.

- Chapter 6: Tag manager application will be described. The capabilities and process behind the functions will be reviewed as well.

- Chapter 7: Data gathered via the survey conducted to measure Tag manager application performance will be analysed. Data will be presented graphically to show the results and identify potential improvements.

- Chapter 8: general discussion, finding, recommendations will be the content of this chapter

Chapter 2 - Engineering Asset Management and Maintenance

Figure 2-1: Word Cloud of Terms used in The Thesis

2.1. Introduction to Engineering Asset Management (EAM)

Engineering Asset Management is defined as "the systematic and coordinated activities and practices through which an organization optimally manages its assets, and their associated performance, risks and expenditures over their lifecycle for the purpose of achieving its organizational strategic plan" (LCI, 2014).

EAM's main focus is on sustainable business outcomes, risk management and value. This discipline is concerned with assets throughout the lifecycle starting from the identification of the need for a particular physical asset, through defining the requirements, the acquisition and system implementation processes, in-service operation and maintenance management, and asset decommissioning and disposal. This entire process involves numerous disciplines and requires a series of technical and management tools and skills. Companies who own and operate physical assets delegate most of related responsibilities to 'maintenance' department to maintain the asset(s) and ensure that it functions well. Over the last 30 years, the maintenance process has changed dramatically due to the changes to equipment design, computerization, electronics and communication, cost pressures and societal acceptance of risk and failures. As maintenance accounts for a major percentage of operating costs, it is now in the center of senior management concerns. The evolution of the term "engineering asset management" was a direct response to the urgent need to adopt better maintenance efforts, and to align internal processes with strategic objectives (Hokiewicz, 2006).

The cause and effect chart shown in Figure (2.1) tries to illustrate some of the influences on the development of EAM. Although many of the main processes on which EAM is founded were developed in the 1970s and 80s, they were not extensively employed until the 1990s. Changes in the type of data that we collect, store and use for purposes of decision making are one of the key drivers for implementation. This process has also made use of the rapid development in functionality and use of ERP and CMMS mentioned above (Hokiewicz, 2006).
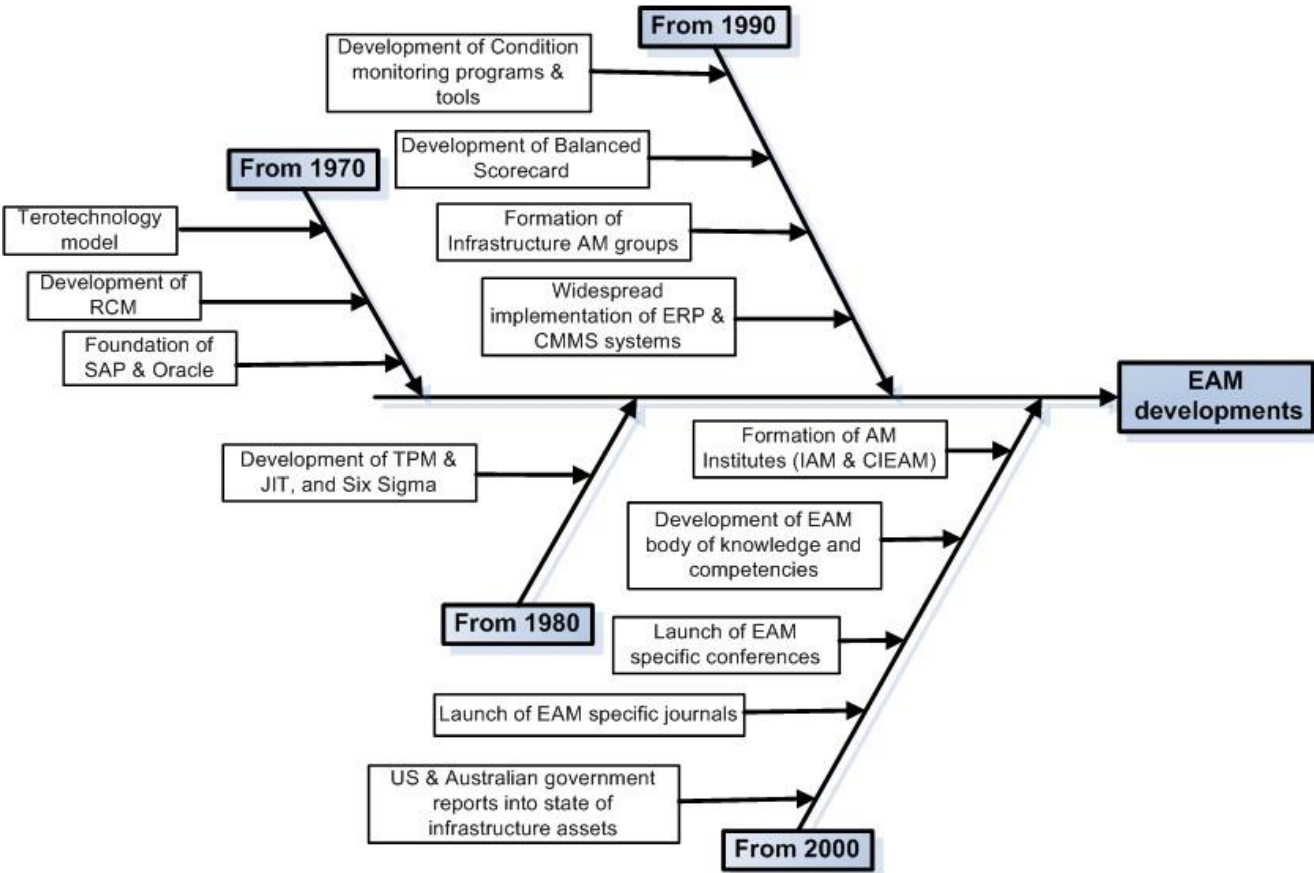
Figure 2-2: Cause and effect diagram illustrating influences on the development of EAM (Hodkiewicz, 2006)

Since 2000 there has been a tangible interest in EAM, as articles, reports, and conferences on this discipline rose as a new trend. Starting in 2004, a number of consortia and institutional bodies were established to represent their national EAM communities: these bodies include the Institute of Asset Management in the UK, the Asset Management Council and Centre for Integrated Engineering Asset Management in Australia, to name a few. These bodies, their associated programs and the opportunities for information exchange at conferences et al, will constitute a major assistance in gaining a degree of respectability for EAM in the eyes of the engineering, business and government communities (Hokiewicz, 2006).

Chapter 3 - Asset Life Cycle Information / Data and Life cycle information management challenges in MMO and EPCIC projects

3.1 Introduction

The giant Norwegian oil and gas fields are in decline, most of these fields have reached their tail phase. This challenge forces oil and gas companies to focus on maintenance and modification to enhance production efficiency and extend field's lifetime. (Höök, Aleklett and Hirsch, 2009).

The increasing percentage of portfolio of projects in oil and gas industry has a significant brownfield element. Large and small modification projects can range from major expansions, debottlenecking, or rejuvenations in an operational plant, to ties-ins of a new facility into an existing system and drilling facilities upgrades (Visser & Brouwer, 2014). Hundreds of millions of dollars investments are invested in new oil and gas facilities and significant amounts of money are invested in brownfields facilities to keep them operational and economic. This brings new business opportunities for money contracting companies. Contracting companies realise the challenges related to modification projects offshore as most of brownfields projects modification activities will be performed in an operating asset that means that any extended shutdowns will have a direct impact on production. Other factors such safety risks are considered to be a challenge because all work will be done in hydrocarbon environment. Cost and schedule overruns are examples of challenges and difficulties that stress companies in brownfield projects.

Many Greenfields projects are under design phase in the Norwegian continental shelf. LUNDIN, ENI NORGE are for example working on two new fields. The investment is huge and all work activities should be planned to ensure that projects will not be delayed. Life cycle information management is something that all companies have to give a great amount of awareness and consideration. Information and data are the fuel that keeps most of the activities running.

3.2   Data and information management

Maintenance and modification projects are playing an important and essential role to keep aging oil and gas platforms and assets in the North Sea operational as most of the fields offshore are reaching their tale phase. Aging assets offshore combined with stricter financial constraints and strict regulations has made Asset management on the top for priorities of all oil and gas companies.

Aging assets in North Sea and declined production make authorities open to give licenses for new oil and gas fields that implies awarding EPCIC (Engineering, Procurement, Construction, installation and Commissioning) contracts to many contractor companies from operator companies whilst awarding many other maintenance and modification contracts to contracting companies to improve and extend life of operational assets offshore (Raza & Ratnayake, 2012).

Asset management involves managing brownfields and Greenfields with the purpose of turning assets into a revenue stream.

Many factors are considered in small and large modification projects; those factors affect the quality of deliverables and guarantee the successful execution and completion of modification projects. Technical information, competencies, team work, tag management, communication and quality assurance are among these factors (Raza & Ratnayake, 2012).
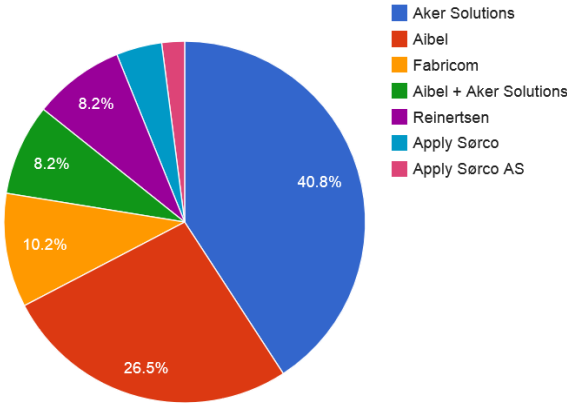
Figure 3-1: Overview of Engineering Contractors' Share in Maintenance and Modification Projects in the Norwegian Continental Shelf (Offshore.no As, 2014)

It's a very challenging task to manage projects critical information. This challenge changes with the scope of each project. Projects information in MMO and EPCIC projects are delivered from numerous project team, contractors, equipment vendors and suppliers and manufacturers from different locations locally and globally. The complexity of offshore projects makes applying technology solutions to the mountain of information generated critical to enhance information accuracy and timely decisions. In addition, technology can help to ensure the access to the latest project engineering information that affect the quality of

deliverables. It also minimises the amount of work needed to achieve common tasks and goals from project initiation through completion.

The new Greenfields projects in the North Sea which came as a response to the need of compensating for declined production of the giant Norwegian oil and gas fields share many common characteristics: they are large, expensive and require an extended supply chain. Effectively managing engineering information in these projects requires tracking the major changes to meet the complexity and huge amounts of data in such projects. Use of well-controlled engineering data increases possibilities of success in design, construction and operation of oil and gas installations and fields (Marston, 2013).

All oil and gas companies realise the fact that insufficient engineering information management will have an impact on the industry's success and the companies' strategic goals, as a matter of fact. IBM has investigated usage of engineering information management systems through a survey which was directed towards many large oil and gas organizations, the results show that many companies use processes which do not align or integrate with business operations. This results in duplicate or poor quality information. The study also showed and identified significant added costs, time wasted spent to search for information or updating and recreating information, inefficient use of data in decision making, delays in projects schedule as well as many health, environment and regulatory risks (Marston, 2013).

According to IBM's study, it can be argued that the rating of the current state of management of technical data and information in oil and gas projects is less than satisfactory and a great amount of work is needed to bridge the gap between the necessary data and information management systems and the existing systems and work processes used in EPCIC and MMO projects.

Many areas can be affected by deficiencies of engineering information and data. Affected areas can include cost, schedule, safety/ health, environment and regulatory matters. These deficiencies are generated and caused by many challenges during the lifecycle of MMO and EPCIC. The effective implementation of better work processes and technical data and information management systems is hindered by lack of resources (cost, time, priority and competence), complexity of technology, and difficulty in creating ease of use, normal work processes and perceptions.

Despite the fact that Norway has become a leading country in oil and gas industry, many gaps still need to be bridged and many issues need to be tackled. The Norwegian Oil Directorate held a basis study which resulted in many findings related to struggle and challenge regarding technical documentation and technical information flow among parties. Technology, people and process are the key elements which are needed to improve the efficiency and value of information and data flow.

Oil and gas companies do their best to avoid any overruns. Companies started to pay attention to the importance of data during projects, especially in EPCIC projects. Smooth flow of information and technical documents plays an important role in meeting the project's schedule and planned costs. The quality of data is an important issue as well, and all project's parties are responsible for data quality and accuracy. The old fashion of work was to deal with data and documents as a problem, which implies that handing over data and other technical

documents to the next party was considered a relief of a heavy load. Nowadays, all companies share the responsibility of data quality, and the overall quality of projects is the main thing that matters. Suppliers, contractors and other parties are considered as partners and their performance in projects will play a significant role in meeting project's millstones and budget.

3.3   Asset life cycle information

Oil and gas industry is an asset-intensive industry. A vast array of plant and field assets for production, processing, refining, and bulk transportations and distribution is needed. Tens of millions are spent on maintenance, and billions are spent on new fields in construction investments. These huge costs push oil and gas companies to their limits; this means that latest asset management and maintenance management concepts and systems must be used to leverage the latest technologies to maximize uptime and increase operations efficiency whilst maintaining a high level of safety.

Oil and gas companies experience many challenges and obstacles, most of these challenges and problems are related to asset management issues. Companies work in ultra-**competitive** markets which means that maximizing uptime throughout asset life cycle is essential. Assets must not be out of commission or operate below peak efficiency, in order to enable companies to keep traction in high competitive markets. **Innovation** is another aspect of the challenges related to asset management as changes occur continually in technology. That indicates the companies' need to upgrade facilities on a regular basis during the lifecycle of these facilities. Maintenance and modifications projects are needed which requires major shutdowns to be executed with high speed and high efficiency, avoiding huge production losses. Management systems and software must be available to arrange and manage these shutdowns, ensure effective workflow, and minimize downtime. **Compliance** with regulatory requirements is very important in managing high risk facilities in oil and gas industry. Authorities do not tolerate any non-compliance or regulation violation from any company; this means that companies in oil and gas industry must maintain and document their compliance with HSE regulations and other standards during the lifecycle. This includes managing a considerable range and flow of information to ensure its accuracy, availability, and accessibility any time point during the lifecycle. Reputational risk is a major concern in oil and gas industry, and the Deepwater Horizon disaster was a clear example of reputational damage that could happen to companies working in oil and gas industry. BP was about to go bankrupt as a result of costs and losses of this accident. Unexpected equipment failure has the potential to cause environmental incidents, production losses, and regulation violation.

One of the key factors in managing assets during life cycle is the solid understanding of all processes. Managers should have a clear image about the different processes and activities related to operation and maintenance of assets. Deploying and implementations of tools and management systems comes as a second step in managing assets during their lifecycle. The main goal of all asset managers is to increase uptime and minimize downtime. This can be achieved by running assets at peak capacity which demands effective planning, strong asset management strategies and investments in asset management tools and application (OpenText, 2014). One of the most challenging issues in oil and gas industry is the functionality gap of Asset management systems used by the companies. The systems lack the

broad functionality when it comes to managing enormous amounts of asset-related information. It is also a challenge to integrate and correlate that information with other management applications without substantial integration work which could be a source of risks.

Information management is defined as:

"The treating of key project information as an "Asset" and managing it as such, bringing to bear the appropriate technology tools and techniques to develop solutions to real project needs, while adding overall value."(Saines, 1999).

IBM defines information life cycle management (ILM) as*: '' Information Lifecycle Management (ILM) is a process for managing information through its lifecycle, from conception until disposal, in a manner that optimizes storage and access at the lowest cost''* *(*ILM Library, 2007*).*

Information technology (IT) is often confused with information management. Despite the link between these two areas, there is still a difference. Information management is considered to be a core project management discipline. The traditional project engineering and management's role is the application of latest available information technology applications/tools combined to support and facilitate work for information management staff during projects. Nowadays, Information Management is an important and vital element in project management.

Poor asset information can be disastrous. The investigation committee which investigated the Deep Water horizon disaster published some of the stories related to data and information management of the drilling rig where the disaster took place.

"We learned that the blowout preventer had been modified in unexpected ways…"

"… BP told us the modifications on the BOP were extensive. After the accident, they asked Transocean for drawings of the blowout preventer. Because of the modifications, the drawings they received didn't match the structure on the ocean floor …" (Chew, 2013).
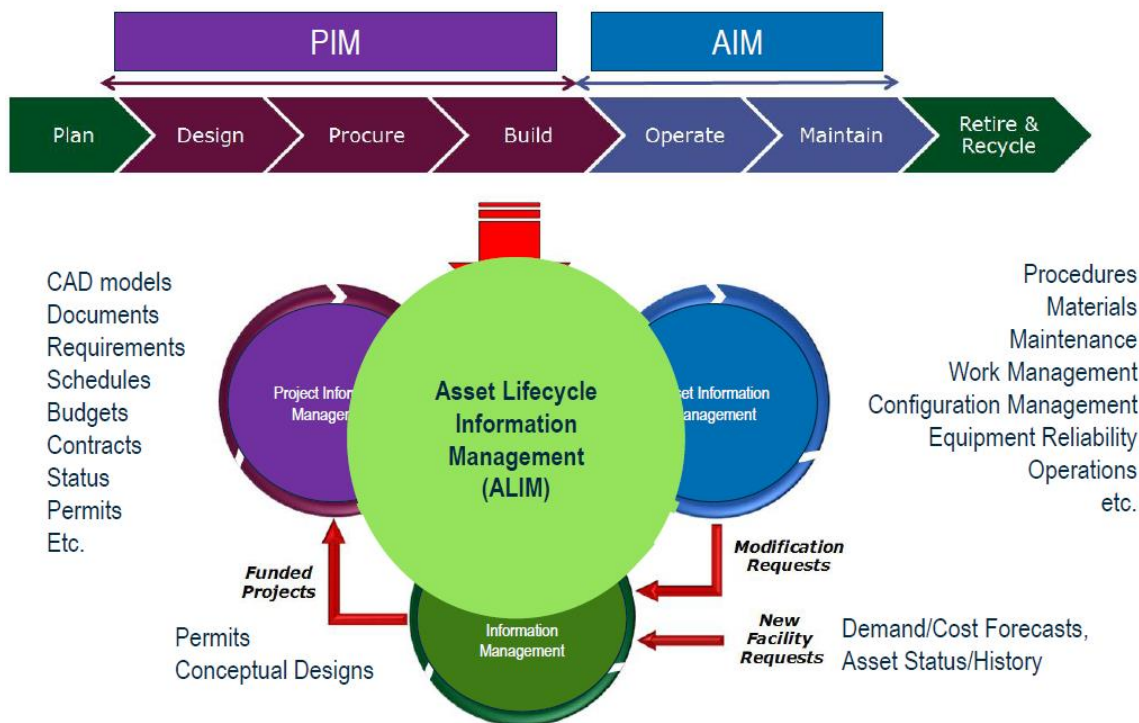
Figure 3-2: Asset life cycle information management (ALIM, 2014)

3.4   Project Execution Model (PEM)

Project Execution Model (PEM) describes and highlights the important aspects of the project. Project Execution Model includes all aspects of a capital projects from inception through achievement of final project objectives, while addressing all pertinent workflows. A well-defined project execution model guarantees project management efficiency, quicker start-ups and speed to market (Polytron, 2014).

 Early planning of MMO and EPCIC projects is vital to avoid overruns. The complexity of oil and gas projects, the requirements of timely delivery and other concerns as quality/HSE factors made establishing management tools as Project Execution Model in oil and gas industry a must. PEM principles and phases have been integrated into project management software systems such as planning progress, reporting systems, tag management tools and 3D design systems (Fagervik, Plassbak and Yong, 2012).

Linking project phases in PEM to computer-based systems gives real time management information necessary to implement the right measures to achieve milestones. This helps to avoid the expensive and time-consuming delays in the construction phase.

Contractor companies such as Apply Sørco, Aker Solution, Aibel, and other companies that work on many MMO and EPCIC contracts in the North Sea, perform new product development (New Projects, EPCIC). They also support offshore facilities through maintenance and modification projects (M&M). Projects execution model for New projects developments is shown in figure below. These projects include new installations in Greenfields. Most of the companies mentioned above have their own PEM; they have many

common things in managing EPCIC and MMO projects. The PEM figure below describes the main phases and milestones during new projects developments.
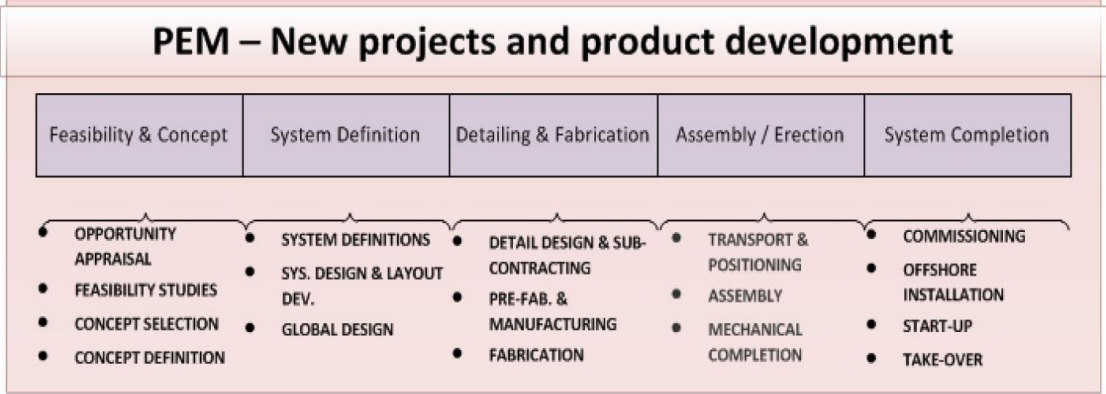
Figure 3-3: Project Execution Model (PEM) for Greenfields Projects (Mjånes, Haskins and Piciaccia, 2012)

Maintenance and modification projects have a shorter lifecycle than EPCIC projects, but they still have considerable amounts of technical data and information in need for effective management strategies. Most of companies that work on maintenance and modification contracts share a common PEM for maintenance and management projects and Maintenance and modification projects. PEM for maintenance and modification projects is described in figure below.

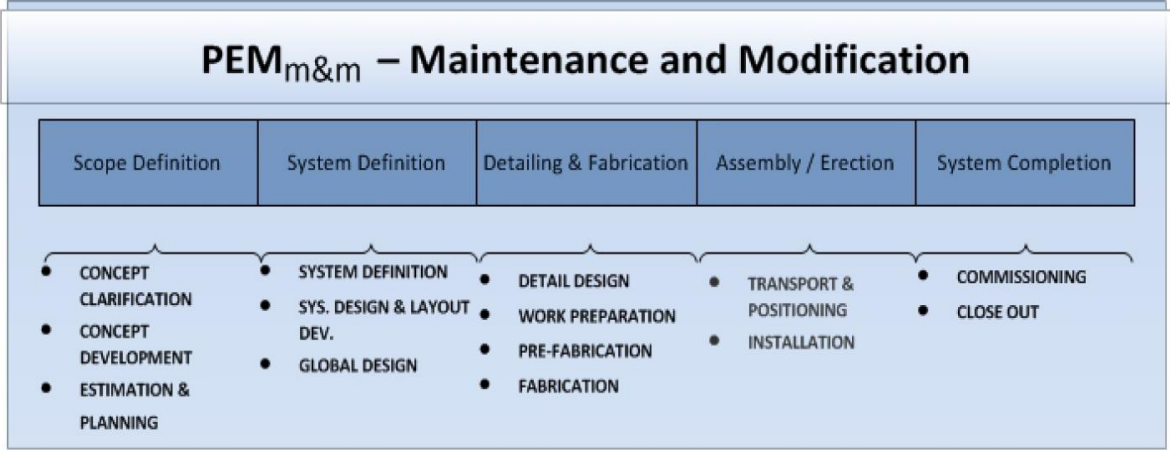Figure 3-4: Project Execution Model (PEM) for Maintenance and Modification (M&M) Projects (Mjånes, Haskins and Piciaccia, 2012)

Mountains of information are generated during these different phases which require effective implementation of different IT solutions to enable different parties and teams to use the data they need in a timely manner. Information management during the lifecycle of EPCIC and MMO projects affects the quality of projects, and it is known that quality product leads to attaining the trust and confidence of the Oil and Gas Company (Client) for long term success in EPCIC and MMO projects. Oil and gas companies became more demanding because of the enforced regulations and the need to comply with the government's strict rules. This led to force the engineering contractors into tough, competitive bidding. Oil and gas companies increase their resources to oversee the contractors' performance which would, in turn, push these contractors to their limits. Oil and gas companies also tend to screen contractors before choosing the final list for contracts open to bid by these companies.

Continuous improvement of day to day operations performed by contractors, alongside with continuous improvements of project management tools, is essential in oil and gas industry to generate more profits. This can be reached by extending the scope of work and integrating quality to achieve quality improvements and client satisfaction. Companies could face troubles in markets and fail to compete if they do not adopt improvement systems, policies, and strategies (Sylvester and Rani, 2011).

3.5 Data and Life cycle information management challenges in MMO and EPCIC project

NORSOK Standard defines life cycle information (LCI) as *"The information required by the company for engineering, preparation for operations, start-up up, operation, maintenance, repair, modification and decommissioning of a plant. LCI includes both information submitted to the company and retained by the supplier on behalf of the Company. LCI includes what has previously been termed Documentation for Operations (DFO)".*

It is very important for contactor companies in oil and gas industry to start work on projects as early as possible to meet the project's milestones. The availability of information required in different phases during the lifecycle of projects is something not to be neglected. Technical information is the brain of good deliveries throughout the project's lifecycle. Therefore, information should be complete and accurate to enable engineers to perform their duties in an effective manner. Information completeness ensures that all maintenance and modification activities are done based on highly reliable sources. This would help in achieving more progress and reducing processes bottlenecks. Asset information has a value that is very critical to properly design, construct, operate, manage and modify operating facilities. Furthermore, asset information is considered as a collective knowledge used in managing facilities throughout their lifecycle. Asset information is used by a diverse set of people and systems, each with their own concerns, requirements and special needs.

The main goal of Asset information management is providing timely, accurate, complete, consistent and compliant information which allows safe and efficient decisions.

Information in EPCIC and MMO projects has different forms and sources, it could be:

Drawings	Vendor manuals
Equipment and instrumentation lists	Vendor supplier
Engineering specifications	Vendor supplied spare information
Acceptance test records	QC, checkouts and commissioning records.
Emergency action plans	Engineering standards
Engineering drawings	Facility/asset management
Facility drawings	Maintenance manuals
Process flow diagrams	Specifications

Table 3-1: Information and documents needed to operate assets

3.5.1 Many parties involved

In EPCIC and MMO projects, companies tend to find a contractor company that should do all the modification work; this includes buying and installation of the equipment. Those contractors have their own supply chain which contains many manufacturers, other suppliers, and third parties.

The complexity of projects and the huge budgets bring a number of other main participants in MMO and EPCIC projects in addition to the owner. The process supplier in such projects is usually an engineering company which provides services related to engineering design and technology. Trade or subcontractors and major vendors engaged in MMO and EPCIC projects can work for the EPCIC contractor or directly for the owner.
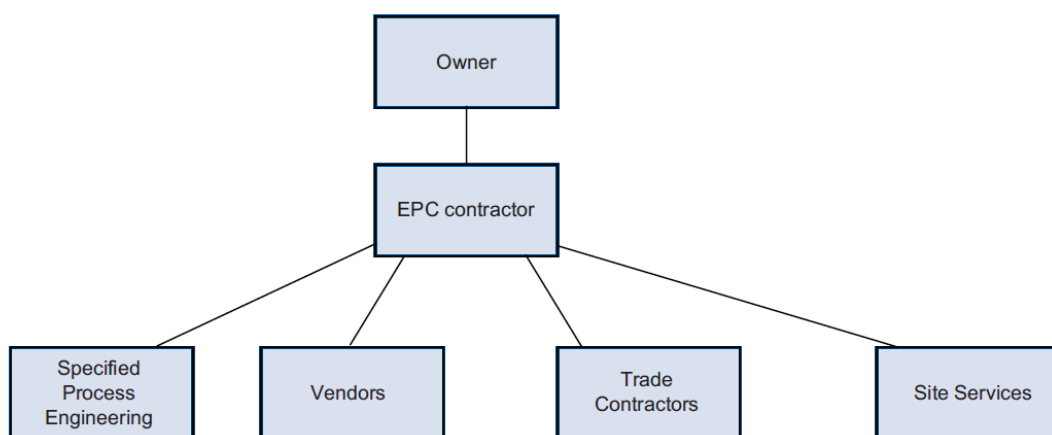
Figure 3-5: EPC Arrangement (Galvinich, 202).

All these parties involved in EPCIC and MMO projects must understand the importance of information needed in the engineering phase and further in other lifecycle stages in the projects. They should also work in coordination with the contractor or the owner to improve the efficiency of the process of data handover. The information flow should be managed and agreed up by all parties with the objective of meeting the project's milestones. Inefficient management of information among parties may lead to delays which increase the risk of failing to meet the overall project schedule.

Cost, quality and time are the three main dimensions which play a significance role in choosing the proper suppliers by the contractors or the owner. Quality of all deliverables and services including information is a very important dimension in EPCIC and MMO projects. Information is considered as an asset or a delivery that should be submitted under certain conditions and specific standards. Efficient Information flow is an important consideration; suppliers should show and approve their willingness to adjust their procedures to meet contractors and owners projects' needs (Galvinich, 202). Companies use innovative ways to improve efficiency of information flow through. They make use of information technology which results in benefits for all parties to streamline information flow.

The volume of data generated by different parties in EPCIC and MMO projects and the complexity of such projects make the process of managing information a challenging task for oil and gas companies. There should be proper planning combined with using the most efficient IT tools available to reduce any risk that would affect the quality and the time schedule of projects.

Many manufacturers struggle delivering the required information on time. They experience problems with the ''AS-built'' data which must be in place some days or even weeks before the commissioning phase starts at the end of the construction phase.

Quality plans are usually agreed upon among owners and suppliers. Quality plans is one of the tools used to enhance information flow between owners and suppliers.

3.5.1.1 Quality Plan (LCI requirement - supplier):

Suppliers are considered as partners and the quality of their products and services affect the whole project's life cycle. Oil and gas companies tend to include suppliers as early as possible into quality planning to achieve the best results throughout the lifecycle of projects.

The objective and the target of quality plan prepared by oil and gas companies (Owner of projects) is ''*to identify requirements for delivery of life cycle information (LCI) from equipment and material suppliers. The requirements are based on the Norwegian standard NS5820'' (*Statoil LCI, 2007*).

Lifecycle principles and requirements are found in the quality plan or the governing document, and all documentations and other works delivered by the suppler should be completed according to this quality plan:

> ''*Life Cycle Information shall be provided in accordance with this document and, where relevant, standards listed under "References". In case of conflict between referenced standards and this document, the latter shall apply. The supplier shall request clarification from the Purchaser in cases of uncertainty or conflicts between standards'' (*Statoil LCI, 2007).

The requirements are applied to any other subcontractors who work with suppliers.

> ''*The requirements in this document and the above standards shall also apply fully to any sub-suppliers. The supplier shall incorporate details of sub-supplier scope within their own document and engineering indexes.'' (Statoil LCI, 2007).*

The availability of information is also an important consideration in lifecycle information requirements; suppliers must assure early access to information, in order to avoid any delays during life cycle.

> ''*Early access to information: Purchaser and Company's project and operations organisations require access to supplier information at an early stage for interface engineering purposes, factory acceptance testing, installation, commissioning, start-*

up and to facilitate preparation for operations activities. Supplier shall make information available in accordance with the early requirement dates listed in the SMIR. In addition, the Purchaser reserves the right to call for any documentation/information at any stage of preparation.'' (Statoil LCI, 2007)

As-built data which must be delivered before commissioning phase should be available *in digital format*

''The Supplier shall deliver as-built documentation/information included in the User Manual in digital format. This shall be considered by all parties as the "original". (Statoil LCI, 2007)

Operators and contractors have many suppliers and manufacturers; the volume of data generated by all these suppliers should be managed and coordinated in a common data base which allows access to these parties. Software tools are widely used to manage lifecycle information database. Web portal applications has enhanced data and information availability and solved many problems that caused many bottlenecks and delays before using such a technology. Detailed information about engineering numbering system, tag numbering, user manuals, LCI documents requirements can be found in the quality plan. Suppliers have to follow all principles agreed upon in the quality plan; otherwise, many deliveries will be rejected by Owners.

3.5.2   Document control, transmittals and handover:

Document control is a very important factor in information management and asset management. Document management has the potential to increase asset management's efficiency which leads to capital projects success. Revisions in projects must be continuously tracked and integrated and should be available to different parties involved in the projects; a historical revision should also be maintained. As companies deal with a huge amount of documents and information, they should set up a clear strategy and plan to handle this overwhelming amount of information and documents. It should be indicated that it is a matter of thousands of documents in EPCIC Projects. Maintenance and design documents should be available to engineers, vendors, and plant personnel with the latest updates and equipment changes. Owners and operators must assure that information passes successfully, efficiently and consistently from one lifecycle phase to the next. The handover of information in different phases during the lifecycle is described briefly in the next section. It should be notes that all activities in EPCIC and MMO projects are based on decisions made by managers and engineer in a preliminary stage called the planning and programing phase. As an example, owners assess the condition, productivity, costs and efficiency of the facility. This assessment is based on information gathered by the owner and other parties involved in the work performed on the facility. In some projects, the analysis result may show a need for initiating a modification or a total upgrade project.

3.6   Information Needs and Handover Process in EPCIC projects

Asset lifecycle can be divided into seven major phases; each phase has its information requirements. A brief account for each phase is given below:

3.6.1   Design/Engineering

Project requirements are translated into a comprehensive physical description of the facility in the design phase. This phase is the most critical phase during the whole life cycle; the quality of information and decisions made can affect the eventual outcome of the project (Fallon & Palmer, 2005). The amount of information created in this phase is huge and essential for the other phases in asset's life cycle. The parties which are included in this phase are coming from different organizations, each represent a specific discipline. Information sharing between these parties is important and has a great effect on progress and quality of work achieved.

3.6.2   Procurement:

In this phase the contractor will be responsible for preparation of invitations to tender and then to award the contract for delivery and construction to third parties and other suppliers. Contractors work on preparation commercial and technical agreements in this phase. All terms and conditions must be agreed with owner. Information related to quality and timing of deliveries is agreed as well, suppliers show their experience and can refer to other references they worked with.

3.6.3   Construction and Installation:

In this phase, the construction contractors will be responsible for the overall management and coordination of activities. They have to work in an efficient manner to assure that all work and deliveries are done according to schedule and within cost constraints. Contractors also assure that all the work being done is in compliance with safety regulations. The information describing the facility designed in the design phase is the main source of information in this phase. New information comes in by construction contractors which include product sourcing, detailing, fabrication and assembly processes and construction schedule (Fallon & Palmer, 2005).

Designers, engineers and other decision makers can clearly see the perfectness of a job they have done through engineering and design phase in the construction phase, as the accuracy and completeness of the design drawings and specifications have the greatest influence on executing the construction of phase on time and within budget.

3.6.4   Closeout

The owner accepts the construction work in the closeout/commissioning phase. All parties, then, assure that all necessary documentations are turned over.   This phase includes the following activities:

- Production systems start up.
- Occupancy certificate is issued.
- Facility use begins.
- Record plans (As-built) are delivered.
- Operations and maintenance manuals are delivered.
- Final inspection is performed

- Final cost report and as-built schedule are generated.

3.6.5 Commissioning

This is a very short and brief phase before the transition to the operation phase. All information from the designing and construction phase should be gathered before moving to the operational phase. The handover point from construction to commission is one of the most critical points in the project's lifecycle. The status of all information and data must be As-built before starting this phase. The As-built status means that drawing and equipment are in their final form, and they are ready for commission and operation.

3.6.6 Operation and maintenance

Operational and maintenance phase is the longest and the most costly phase in the facilities' lifecycle. This phase lasts for decades, and the way owner manages the asset affects the cost and profits of the company. The high cost and complexity of activities in this phase make benefiting from information handover in a structured form a must. Computerized maintenance management systems (CMMS) and Enterprise Asset Management Systems are two common software tools used in oil and gas industry to facilitate use and handle of maintenance and operation information. Users of information during this face include many parties such as: Owners, operators, vendors and other service providers.

The source of data in this phase is the information coming from the closeout/commissioning phase. Information is also generated during this phase. Decision makers and engineers use this information to improve asset performance and increase profitability. Production information, service requests, maintenance schedules, inspection plans, work orders, equipment shutdown, operation costs and maintenance cost are the common types of data generated during this phase. These different categories of data have a significant role in deciding whether to dispose or expand use of the facility. It should be mentioned that there are many other projects that take place during this phase. These might have an impact on the facility during this phase. Major systems or equipment upgrades, additions and renovations have their own project's lifecycle and information requirements. One of the major challenges facing operators is updating the overall facility information base with the projects' specific changes (Fallon & Palmer, 2005)..

3.6.7 Disposal

The disposal of any facility can be achieved by demotion or transfer of its assets. Some companies sell equipment and other assets that can be reused. As a matter of fact, information related to assets is included in selling process. Information from design phase can be used in case of demolition, this includes information about material and quantities and forces needed to collapse the structure (Fallon & Palmer, 2005).

3.7 Data Quality

As mentioned earlier, information is considered as the backbone of all activities in EPCIC and MMO projects. All these activities are dependent on the availability and quality of the information. The term garbage in, garbage out (GIGO), which illustrates that that the quality of output which is received from a computer program is dependent on the quality of input information, is applicable in information management throughout the lifecycle of EPCIC and MMO projects; design data, tags, technical data, equipment specification are the input of

many activities during EPCIC and MMO projects. This means that poor information delivered by suppliers and other different parties will affect the overall quality of the project deliverables. The cost is affected as well due to the huge amount of rework that should take place. When we talk about data and information in EPCIC and MMO projects, we should mention the data quality dimensions that shape the quality of information these projects.

- Clarity: The information should have a clear and shared definition. People who use information and those who build it should use the same codes that indicate the same meaning.
- Accessibility: Is it easy to access the information? Where can the information be found and who has access to it?
- Usability: The usability measures whether information is structured and built to different parties and people who have different interest and needs of this information.
- Consistency: information coming from different sources should be consistent in terms of naming, values and relationship.
- Completeness: How much of the required information is available. The content of each information package supplied is complete and does not lack any necessary information that would make a bottleneck of delay in some activities.
- Timeliness: The information required is available at the time; this information is up to date and all information updates are included.
- Accuracy: The information should be reliable with no errors that would result in rework and quality problems. Information should be close to the truth and fulfil different parties' needs.
- Cost: The information should be gathered and stored efficiently; this can be achieved by using proper IT tools to help minimizing maintaining lifecycle information costs. Sometimes companies pay much to secure data and information needed for critical activities, and this should be minimized by planning the priority of data packages that should be supplied by suppliers and third parties (Fallon & Palmer, 2005).

As discussed earlier, quality plan is a very important element in improving the overall quality of projects through targeting the source of data and enhancing all incoming information and data from the sources. The quality plan can be described as an information quality management framework which describes the information handover in terms of coding, timing, contents, scope and procedures. Quality plans and frameworks ensure that:

- The required information is handed over in an appropriate format.
- Quality metrics for information and handover process are applied to make sure that information is delivered in the required quality.
- The correction procedures are performed in case of wrong data found.
- There is a reference data coding structure, this is related to structure data.

- There is consistency assurance.

3.8   Data availability

All information flowing among different parties must have a purpose. The availability of data has a great effect on the project's progress, and if important information is not available, consequences could be dire. The consequences severity is a good measure of the importance of information. Information is ranked based on its unavailability consequences. Companies and parties involved in EPCIC and MMO projects dedicate their resources to ensure the availability of their important data and information. Information can be ranked according to the following measures:

Essential: Information which should be retained to the full lifecycle of the facility. This type of information is very important, and the company might be subject to risks in case of its unavailability..

Mandatory information, regulations compliance: Information has no direct need in operation or design, but it is still needed due to authorities' regulations.

Phase Specific: the kind of information that is developed in one specific phase, and is only useful for this phase and has no use in the operational phase of the facility.

Chapter 4 - Norwegian Standards and Regulations - Life cycle information Compliance Challenges

4.1 Introduction

Authorities in oil and gas producing countries try to control and manage the risk that could occur during oil and gas activities. Companies are forced to follow many strict procedures and policies to ensure that all activities are safe and will not harm environment. A clear example of this issue is the new regulations regarding competence management for oil and gas technical and worker. Service companies for example have to show their competence records, this included all training courses were given to technicians and maintenance staff. All people who work on tools have to go through mandatory courses related to the job heir are doing, this came after Mexican gulf accident.

Norwegian Authorities understand the importance of technical information during different life cycle phases. Absence of sufficient and complete information has a great effect on safety of people. All information needed during the different activities must be in compliance with regulation. Companies who fail to comply with information requirements regulations would face many obstacles and troubles and this would delay the projects and cause huge losses and costs.

Some Information created during design and engineering phase is used during the whole life cycle of the facility, other information is required to comply with regulations regardless the functional value of this information. The importance of this information arises when unexpected accidents occur where money and costs can be something marginal compared to fatalities and environmental harmful consequences. Oil and gas companies should have sufficient internal resources to deal with the amount of data and information, these people work also to achieve and reach a satisfactory compliance level all over different area. Life cycle information legislations aim to support companies in building a strong life cycle management with clear and well understood documented processes. Regulations and compliance assists companies to ensure business objectives are understood and all resources available in the company area aligned to support strategic objectives. Following the regulations ensures that information received by different parties in different asset life cycle phases is reliable, accurate, timely and complete.

Oil and gas companies focus on three main areas to avoid any conflict and to ensure an effective approach of complying with regulation whilst managing risk and achieving management strategic objectives. Governance, Risk management and Compliance – GRC, is an integrated approach used by companies to comply with guidelines set for each category, GRC is an approach used to achieving high standards in there three overlapping categories.

Governance: setting business strategy & objectives, determining risk appetite, establishing culture & values, developing internal policies and monitoring performance.

Risk Management: identifying and assessing risk that may affect the ability to achieve objectives, applying risk management to gain competitive advantage and determine risk response strategies and control activities.

Compliance: operating in accordance with objectives and ensuring adherence with laws and regulations, internal policies and procedure and stakeholder commitments.

This part will do through the different regulations related to the life cycle information in oil and gas facilities. NORSOK standards and other relevant regulations will be reviewed and discussed. PTL.no regulation will be also reviewed.

It's worth mentioning that Statoil, the Norwegian oil and gas giant, have an active participation in local and international Standards to influence the resulting standards and reflect the needs of Statoil from these standards. Statoil have been working on bridging the gap between international and NORSOK standards they work also on transferring NORSOK standards to relevant international ones.

4.2 Norwegian legislation and standardization

Petroleum Safety Authority Norway is an independent government regulator with responsibility for safety, emergency, preparedness and the working environment in the Norwegian petroleum industry. This authority supervises all activities starting from planning of development project and continues through the design, construction, operation and removal phase ((PSA, 2014)).

The regulations defined by PSA must be followed by MMO & EPCIC contracting companies in order to achieve a safe and a reliable work environment. This applies for all parties included in MMO and EPCIC projects as operators and suppliers as well. PSA has defined many regulations guidelines, regulations and guidelines cover areas such as: Framework HSE; management, technical and operation, facilities and activities.

The next part will be for talking about some of these regulations which are related to MMO and EPCIC projects. These regulations guide oil and gas companies and describe their roles in management and information providing duties in petroleum activities.

4.2.1 Management regulation:
Work Processes, section 13 (PSA, 2014)

The responsible party shall ensure that the work processes and the resulting products fulfil the requirements related to health, safety and the environment.

The interaction between human, technological and organisational factors shall be safeguarded in the work processes.

Work processes and associated interfaces of significance to health, safety and the environment shall be described. The level of detail in the description shall be adapted to the importance of the process for health, safety and the environment.

Information, section 15 (PSA, 2014)

Section 15 in PSA regulations describes some of the requirements related to information management related to oil and gas activities.

The responsible party shall identify the information necessary to plan and carry out the activities and improve health, safety and the environment.

It shall be ensured that the necessary information is acquired, processed and communicated to relevant users at the right time.

Information and communication systems shall be established that safeguard the need for acquiring, processing and communicating data and information.

4.2.2 Framework regulation:

Management systems that the operator and other participants have established for their activities, should be further developed to include compliance with requirements stipulated in the health, safety and environment legislation.

The licensee and the owner of the onshore facility have a special duty to establish, follow up and further develop management system; this means that the licensee and the owner of the onshore facility shall have management systems to follow up their duty to see to it that the operator complies with its obligation.

4.3 NORSOK Standards

NORSOK (The competitive standing of the Norwegian offshore sector) is the industry initiative to add value, reduce cost and lead time and eliminate unnecessary activities in offshore field developments and operations (NORSOK, 2014).

NORSOK standards are developed by the Norwegian petroleum industry to help oil and gas companies to achieve adequate safety levels and to ensure value adding and cost effectiveness in oil and gas industry developments and operations. Furthermore, NORSOK standards intended to replace companies' specifications and serve as a reference in the authorities' regulations (NORSOK, 2014).

4.3.1 Z-001 Rev. 4, March 1998

This standard describes and defines the extent and details of technical information which shall be available in in the operational phase. The main objective of the standard is to ensure that only necessary information for operational phase is kept available in order to create a safe, effective and rational operation, maintenance and modification of the installation (NORSOK, 2014).

This standard states that all information shall have As-built status right before starting this phase; it should also be available on electronic media.

As-built is defined as: *Documentation where mark-up information has been formally incorporated into a new revision of the original document according to individual requirements for each project.*

We can say that this standard summarizes all the required documentations and other technical information needed during facility operational phase. The information and

data which were generated in different phases during life cycle should be ready for use in this phase; this means the status of al information must be As-built. The standard also states that all information supplied should be limited to information relevant to the actual installation. ANNEX A in the standard includes a detailed list of required documentations such as: document index, design and fabrication specifications, project design criteria, system design reports, operation manuals. Inspection procedures, repair procedures, inspection maintenance and repair, user manual for equipment and tag index, etc. (NORSOK, 2014).

4.3.2   NORSOK Z-DP-002 Coding system

This NORSOK standard is a coding system which has been developed for tag coding and document coding.

- **Document Coding**

The first part of this standard describes the procedure s and rules of documents coding, this includes some emendatory attributes to control the documentation process during project life cycle. The coding states that document should include system, subsystem, document type, area, title, responsible party, revision, revision date and purchase order identification.

Revision codes for example is very important in reaching the As-built status as most of documents do not reach this status without many revisions and modifications on design on the system, subsystem or the equipment described in the document.

Revision codes: The purpose of the sequential revision number, format NN, is to give each revision a unique identification. The two character sequential number starting at 01 shall be given for the documents first issue and shall be increased with one for each revision.

Manufacturer information: Manufacturer's documentation shall be identified according to manufacturer's identification system. The Achilles code for manufacturers should be used.

It's clear that the attention being given to documentation is high due to the difficulties in managing the mountains of documentation during Asset life cycle; thousands of documents are generated during design phase and the best thing to deal with all these documents is following a standard that regulates management of these documents.

4.3.3 NORSOK Z-003 Rev. 2 Technical information flow requirements (TIFR)

This NORSOK standard aims to make the process of information flow among different parties involved in EPCIC and MMO Projects smooth and efficient. The standard assists in enhancing information flow through making a standardized process that should be followed by different parties in engineering/design and operation phases. This means that information is available and fulfils Projects and operational different needs. This can be seen in applying **Concurrent engineering** concepts which support the integration and parallel execution of engineering and manufacturing processes, considering all elements of the product life cycle from conception of the design to disposal of the product (This is also known as simultaneous engineering) (NORSOK, 2014).

It also emphasizes the role of data owner and creator through describing **Ownership of data** which implies the right to create, change and delete data, and to grant rights to create, change, delete and access such data to others. Such grant of rights does not change the owner's responsibilities (NORSOK, 2014).

The NORSOK standard provides requirements for electronic storage and interchange of technical information and data between all parties and during all phases of an offshore installation's life cycle. It defines precise requirements for use of formal standards where these exist. In other areas specific recommendations are given (NORSOK, 2014).

One of the most important tools that must be used during EPCIC and MMO projects is a Common data base which aims to support collection of project-related technical, non-commercial data available for use by all parties involved in a project, independent of the physical data structure(s) employed and of the application(s) used to create, update or delete it. This is also one aspects of concurrent engineering which helps in bridging communication gaps among different parties involved in projects.

The Objectives of the standard are

- *To enable cost-effective electronic information interchange between all parties. Electronic information shall be accepted as an original and treated as such.*
- *To ensure that electronic information at any time has only one source and responsible owner.*
- *Contribute to the production and use of correct data of a known quality throughout the total life cycle.*

The following main principles form the basis for this standard:

- *Open, non-proprietary information structures and formats based on formal standards shall be used. De facto standards can be used where formal standards are not available or not supported by vendor implementations. Tools or applications are not proposed in this standard.*
- *Information structures, data bases and systems that enable concurrent engineering shall be used (i.e. maximise information sharing).*

4.4 INTERNATIONAL STANDARD ISO/FDIS 55001 Asset management — Management systems — Requirements

This International Standard identifies the asset management system's requirements within the organization. It is the organization's responsibility to determine to which of its assets this International Standard applies, nonetheless.

This International Standard can be applied to all types of assets and by all types and sizes of organizations. However, it is primarily intended for use by those responsible for the establishment, implementation, maintenance and improvement of an asset management system, parties involved in delivering asset management activities and service providers, and internal and external parties which assess the organization's ability to meet legal, regulatory and contractual requirements and the organization's own requirements. The following points summarize the information part in this standard (ISO, 2014).

4.4.1 Communication

The organization shall determine the essentiality of internal and external communications related to assets, asset management and the asset management system. It shall define the nature of information it shall communicate, the appropriate time to communicate, the parties involved, and the manner of communication.

4.4.2 Information requirements

The standard states that the organization shall determine information requirements needed to boost its assets, asset management, and asset management system and achieve its organizational objectives. In doing so:

- The organization shall take into consideration the implication of the identified risks, the asset management's roles and responsibilities, in addition to its determined processes, procedures, and activities. It, furthermore, needs to consider the issue of exchanging information with stakeholders including service providers and shall be concerned about the quality and availability of management information needed for decision making.

- The organization must also be able to determine the attribute and quality requirements of the identified information, and the manner by which it shall be collected, analyzed, and evaluated.

- For the organization to manage its information, it shall first specify the required processes to implement and maintain later.

- The organization is asked then to define the requirements for alignment of financial and non-financial terminology used throughout the organization in respect to asset management. It shall also ensure a certain level of consistency and traceability between financial and non-financial data. It must be guaranteed that the data is consistent enough to meet the organization's legal

and regulatory requirements, not disregarding its objectives and its stakeholders' requirements.

4.4.3 Documented information

- The organization's asset management system shall take account of a various types of information sources including documented information which this International Standard requires, documented information for related legal and regulatory requirements, and documented information which the organization itself determines its essentiality to ensure the effectiveness of the asset management system. It's worth noting that the extent of the documented information for an asset management system can vary from one organization to another depending on the size of the organization, the nature of the activities, processes, products and services it delivers, the competence of its staff, and the complexity of its processes and asset(s).

- Creating and updating: In the process of creating and updating documented information, the organization is required to ensure that the information is properly identified and described (information shall be titled, dated, marked by its author, or given a reference number). It also needs to determine the appropriate format (language, software version, graphics) and media (e.g. paper, electronic) used to document information. Finally, the organization shall review and approve the documented information to guarantee suitability and adequacy.

- Control of documented information: Documented information required by the asset management system and by this International Standard shall be controlled to ensure its availability and suitability for use when needed. The organization shall make sure it has an adequate degree of protection to prevent loss of confidentiality, improper use, or loss of integrity. For the control of documented information, the organization shall address the following activities, as appropriate: the distribution, access, retrieval and use of information; how information is stored and preserved, including preservation of legibility; control of changes (e.g. version control); and retention and disposition of information. The organization shall properly identify and control documented external information that was assumed to be of much importance for the planning and operation of the asset management system.

Chapter 5 - TAG Management in EPCIC & MMO Projects

5.1   Introduction

This chapter is the core of the master thesis as it approaches TAGs and tag related information which is considered to be the starting point for many activities in EPCIC and MMO projects in the oil and gas industry.

The chapter will go through some definitions are related to Tag and tags management. It will also examine the procedures followed by many contracting and engineering companies to deal with the thousands of tags in EPCIC and MMO projects. The challenges will also be discussed with a focus on solutions and best practices in this field. The link between tags database and CMMS, SAP and other document systems will be discussed, and practical examples will used to illustrate the importance of tag management to maintenance planning in the EPCIC and MMO project.

I will discuss the importance of efficient Tags and tag-related information flow during PEM and how this can assist oil and gas companies in meeting Projects' schedules and budgets; this is considered as a very big concern for oil and gas companies, tag and tags-related technical information flow through project execution has a great effect on schedules and budgets, projects quality can be enhanced if tag and tag-related technical information are effectively managed.

5.2　Asset tagging/Overview of equipment identification:

The primary goal of the equipment and tagging requirements is to establish a methodology that results in consistent equipment names and unique tag numbers for all equipment, instruments, and associated control signals. This will allow all plant systems, and maintenance management systems to be fully integrated using unique tag numbers for all system components.

The tagging of assets allows for easy identification of these assets, it is also considered as a definite link to the life cycle history stored in oil and gas client's asset management system (Engineering companies' clients). By way of explanation, we can say that it's something similar to giving names to equipment to identify and link them to drawings and other documents throughout different project phases. Every single equipment or item on the platform in the production facility has a name that enables maintenance and operational people to find all information related to this item. Imagine that you have tens of thousands of equipment, how would it be without a proper naming and numbering system for these different items.

Equipment identification normally takes the form of equipment numbering and includes physical assets or functions on which maintenance resources will be located. It is very important for companies to effectively follow a process for equipment identifying. This will have a great impact on many maintenance activities during design and operational phases. Tags generated during design/engineering phase stand out to be the most important element among many other elements during this phase, namely all design activities, requests sent to manufactures, and other activities that rely on tags. The process of managing tags during design/engineering phase affects the progress and the quality of many work areas. Tags status takes different names during the design phase, and this has to be properly managed and followed in order to have control over the project's progress. Companies use their resources to manage the change in information and documents during this phase.

Equipment's tags are the backbone of all maintenance activities on oil and gas platforms. , The tags are the input of CMMS which is considered to be the brain of all maintenance activities related to planned maintenance plans, corrective maintenance plans, opportunity maintenance activities, and all remaining maintenance activities taking place on platforms.

Regulations state that oil and gas companies must have an identification scheme for every single equipment and item registered in the systems before they can start planning for maintenance or use equipment and plan maintenance applications. The creation of necessary equipment identification information is the key starting point for many procedures such as:

- Creation of equipment master information
- Identifying location of information related to different equipment categories
- Searching for equipment status, location, and activity online
- Tracking historical, current, and planned physical location for equipment
- Keeping detailed maintenance and projects logs
- Viewing assembly components.

5.3 TAG definition

NORSOK standard NORSOK Z-DP-002 defines tag as *a unique code that defines the functional location and function of a physical component within a facility. The "functional location" only refers to where the tag is located within a system, NOT the precise physical position* (NORSOK, 2014).

The figure below illustrates what a tag means in different phases. Tags define the functional location of the item/equipment in the engineering phase. The need for the tag in this phase is a design need. In this phase, the tag shows the location of the item in the process and the function it does to fulfil the process need. The tag is then sent to manufacturers with detailed engineering specifications needed to fulfil process needs. All information can be found in supplier's manuals and other technical documents. The tag is considered as an asset that needs to be operated, maintained, and sometimes modified or replaced by a spare part in the operational phase.

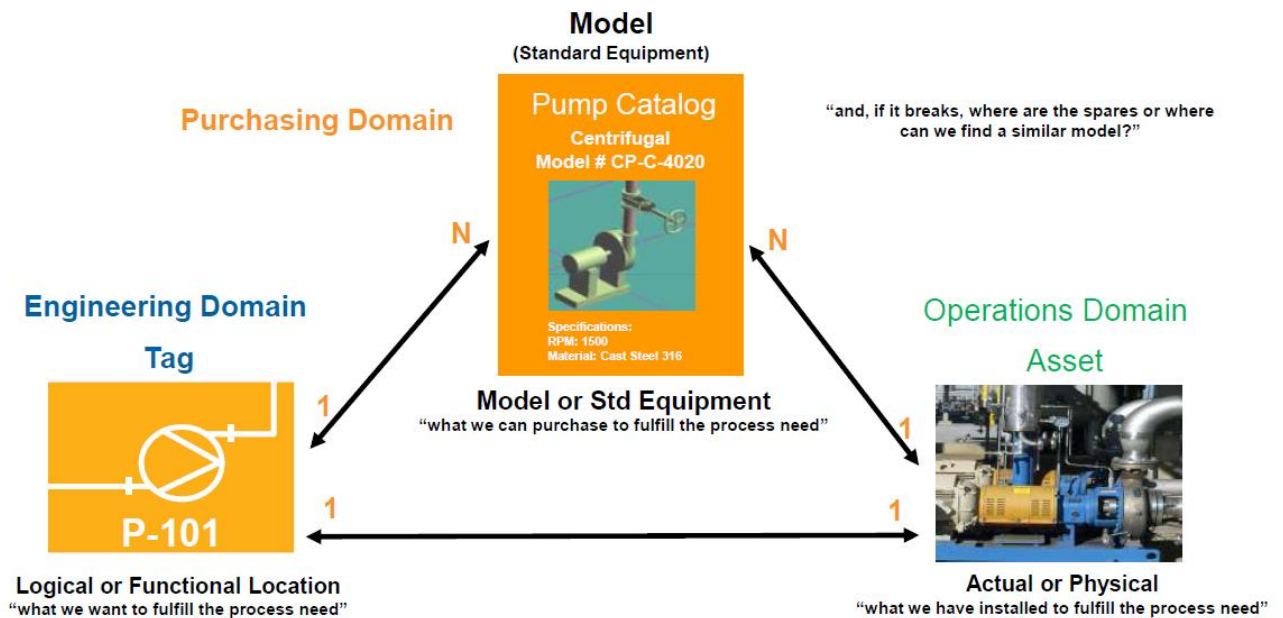

Figure 5-1: Configuration Management (Shirguppi, 2014)

NORSOK standards regulate the equipment tagging and coding in order to achieve consistency. IT applications play a significant role in helping oil and gas companies tackle challenges faced in tag generation and administration. They provide process-based software applications that reflect the process of tag flow in EPCIC and MMO projects.

5.4   TAG management process in Project Execution

In this part, the researcher studies tag lifecycle in MMO and EPCIC projects. In this context, tags lifecycle is defined as the process which starts when tags are generated through the different status of tags during project execution model, until they reach their final As-Built status.

5.4.1   Feasibility and concept phase:

The project execution model for new projects and new product developments starts with the feasibility and concept phase where feasibility studies, concept selection, and concept definition take place. This phase has nothing to do with tags management as it has more generic and strategic decisions. For example, information requirements in this phase are driven by the need to assess the condition of equipment in case of MMO projects. The information gathered by different maintenance technology tools, such as condition monitoring tools, assist in deciding whether the organization should acquire a new facility/asset or modify and existing one.

Once the decision is taken and the company determines to initiate a facility construction or a modification project, the next step is to detail requirements for the facility or the modified assets; this step transits the project to the design phase where all the engineering details, coding and tagging, and other work take place.

5.4.2   System Definition / Detailing and fabrication

The System definition phase includes many activities with the purpose of identifying the main systems managing production facilities. These systems are considered the starting point of Tags management processes. The engineering company identifies the processes and the detailed information regarding main components and equipment. This company is a process supplier that usually has proprietary technology, and its main responsibility is to provide the process engineering design or technology necessary to complete work. (Loots & Henchie, 2007). A separate EPC or EPCM engineering contractor is responsible for the remainder of the engineering design, and sometimes the construction of the project will be considered of this phase's processes. There are many other suppliers and subcontractors who are engaged in projects activities directly by owner or by EPC contractor.

The EPC contractor is responsible for assuring that all information and documentation generated by different parties are according to the regulations. The contracts are awarded to contractors to do most of the jobs during the project life cycle, which means that they are required to use their knowledge, competence and resources to manage all information in EPCIC and MMO projects.

In EPCIC projects, thousands of assets and equipment are used. Therefore, it is a must for EPC contractor to use reliable IT tools that reflect the process of managing tags during project life cycle. The contractor should work in compliance with owner requirements. The information requirements are agreed upon among the Contractor Company and the owner, and this applies, too, on the suppliers, manufacturers and other parties engaged by the contractor.

5.5 TAG Management Process in EPCIC/MMO projects

The systems and all equipment and technology needed to start production are categorized and awarded through contracts to different parties. The different parties should comply with the regulations and the quality plan agreed upon with the contracting company or with the owner.

Suppliers and manufacturers have their own numbering system, and they are supposed to produce and generate tags based on Owner/Contactor ENS. Every asset's tag or ID is the key for documentations and information related to this tag. Tags refer to asset drawings and technical information through references and hyperlinks. A technician onshore/offshore, project engineer, LCC, DC, project manager and many other people should be able to follow information and reach what they need. These different parties use tags and can search any asset/equipment by its unique ID (Tag). Engineering companies generate tags in cooperation with suppliers and other companies that are part in the supply chain of the final assets.

The points below illustrate some of the considerations to be taken before and while tags are generated and managed:

- Vendors, suppliers and other parties involved in projects receive all information related to data and information requirement, this could be a quality plan or supplier requirements documents that show in details the regulatory requirements and owner's specific requirements. Documents which do not follow the procedures and comply with the requirements will be rejected.
- Vendors, suppliers, and other parties define the technology and IT tools needed to support the processes of managing and demonstrating tags during project lifecycle. These companies have their own IT tools which enable them to deal with the huge amount of tags and documents of technical information.
- NORSOK Coding and tagging requirements should be followed and reflected in all tagging procedures. The quality plan and supplier requirements contain references that show the regulations regarding coding and numbering of items to abide by during the lifecycle of projects.
- Tag-related information changes in the engineering/design phase due to design changes, receiving more information, and other considerations during engineering phase. These changes to tag-related information should be managed efficiently. Change management is considered to be one of the main challenges and elements in asset lifecycle information.
- The generated tags and their related technical information should be available for use of different parties. Owners/ contractors should make sure that all information needed by different parties is available.
- Internet web portals are considered to be one of the most efficient tools used to make data and information available for the different parties included in projects. The access to these portals enable projects parties to retrieve information they need from anywhere and at any time.
- The tags generated are unique and generated in a consistent manner to eliminate double tags and other problems related to tags quality. The IT tools help in providing a reliable tag's database to all people involved in project. Quality checks are also performed by document controllers and other data clerks.

- Any problems in tags and tag-related information do not just affect one party. The many parties involved in projects can be affected and this has the potential to result in bottleneck's problems among parties. The need of information for parties is critical; errors and poor quality tags due to inefficient tag management process could reduce project quality and cause delays in project milestones.

- Tag management and administration process has no direct interaction with documentation systems. Tag management process addresses the coding and tagging of assets during lifecycle. The integration between Tag management IT tools and other documentation systems is a very important thing for all parties who work with tags. Tags could be identified by one step if different systems are integrated. This minimizes efforts required to search and find tag-related information.

- At the beginning of engineering and design phase, some thousands of tags are generated; this number increases when project's schedule goes further. The challenges of tags management may be hidden in the beginning due to limited number of tags. Companies start to realise the challenge in managing tags and tag-related technical information when the project reaches some milestones where more and more tags are generated and flowed to main data register. A proper tag management process should be in place as early as possible so companies can handle the increased number of tags efficiently.

Information integrity through project execution model is a vital issue to achieve high quality deliveries within the boundaries of the budget.

Regardless of the scale M&M projects, all involved parties must fulfil the task safely and cost efficiently under the valid regulatory requirements of the company.

This needs continuous communication and deliverables as set out in the Company's PEM. As experience in M&M and EPCIC project execution has evinced, tracking and following up technical documents require the best manual efforts to ensure that no piece of information goes missing or incomplete, coordinating other disciplines (LCI, maintenance etc.) (Raza & Ratnayake, 2012).

Figure below shows the structure of LCI requirements. These customer-defined requirements go in accordance with applicable and governing standard requirements
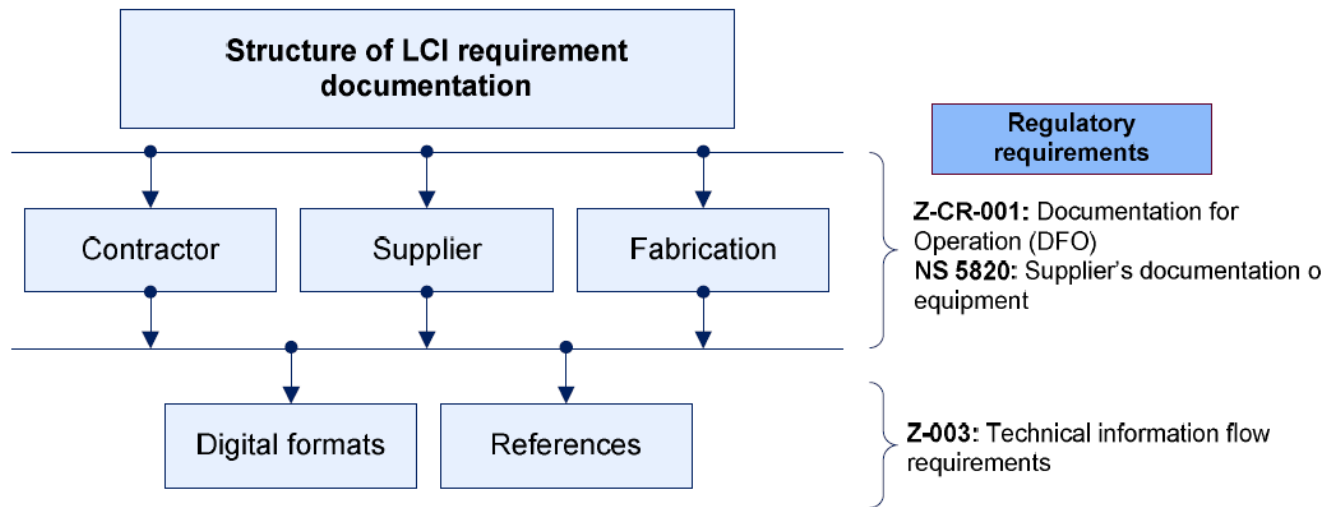
Figure 5-2: Structure of LCI requirement documentation (Raza & Ratnayake, 2012)

The following is a summary of identified deficiencies and challenges facing large-scale modification projects in terms of applicable regulatory requirements and standard practices.

Challenges related to M&M project execution include (Raza &Ratnayake, 2012):

1. Establishing a common ground for effective communication and coordination with the many parties involved in PEM
2. Ensuring effective management of tags and any related technical information during a PEM
3. Enforcing local and global standardization of tag management process
4. Meeting LCI requirements
5. Developing a quality plan between customer and supplier to guarantee the quality of project deliverables
6. Obtaining all necessary technical documentation on time during a PEM
7. Following-up with the supplier in different phases of a PEM execution
8. Keeping a well-ordered master register with an updated status of tags and an extra emphasis on modified, demolished, or obsolete tags, etc.
9. Retaining information of non-maintainable tags such as cables and pipeline information
10. Managing and administering dynamic records and history of all tag(s) in the database
11. Managing updated tag-related technical information in the database.

5.6 Different parties needs during EPCIC & MMO projects and importance of communication

Companies and their staffs find the information they need based on what they know and what IT tools have access to. Most of the companies are granted access to owners' IT systems which are usually web portals. Companies of different disciplines and fields have different needs, for example:

- Projects –search by Document Number, Document Type, or Discipline Operations.
- Operation–Search by Tag and related drawings and vendor documents
- Maintenance –search by physical Asset and location of installation

Electronic integration of work processes between Owners, EPCs and Vendors have a great impact on project quality and communication among different parties. Applying efficient IT tools on tag generation and administration activities results in:

- More rapid processing of Changes, Queries, Deviations, and Documentation
- Consistency of handling and improved traceability ensured via workflows
- Improved reporting and focus of management on project execution issues
- Elimination of paperwork and inducing a single platform for data exchange through availability of web based portals.
- Contribution to achievement of major milestones "sail away"
- Reduction/elimination of Documentation Handover costs to Operations; and this can be achieved through reducing bottlenecks problems and ensuring the availability of information needed for different parties available.

Many oil and gas companies and rig markets struggle with managing documentation integrity in small and large scale modification projects. This also applies somehow to EPCIC projects and could be an additional challenge for companies that lack resources and the appropriate tools. This was proved by a basis study conducted by Norwegian Oil Directorate which revealed that many organizations working in Norwegian oil and gas industry struggle with dynamic updating and validating of the technical documentation (Raza & Ratnayake, 2012).

The studies and researches conducted by companies, individuals and other parties illustrate the importance of managing documentation and technical information in EPCIC and MMO projects. Using proper tools and competent resources is vital for reaching project's milestones on time and to cost. Execution of project activities must be flawless and it should be kept in mind that Mistakes are costly.

The figure below illustrates the importance and role of technical information in managing technical information in modification projects.
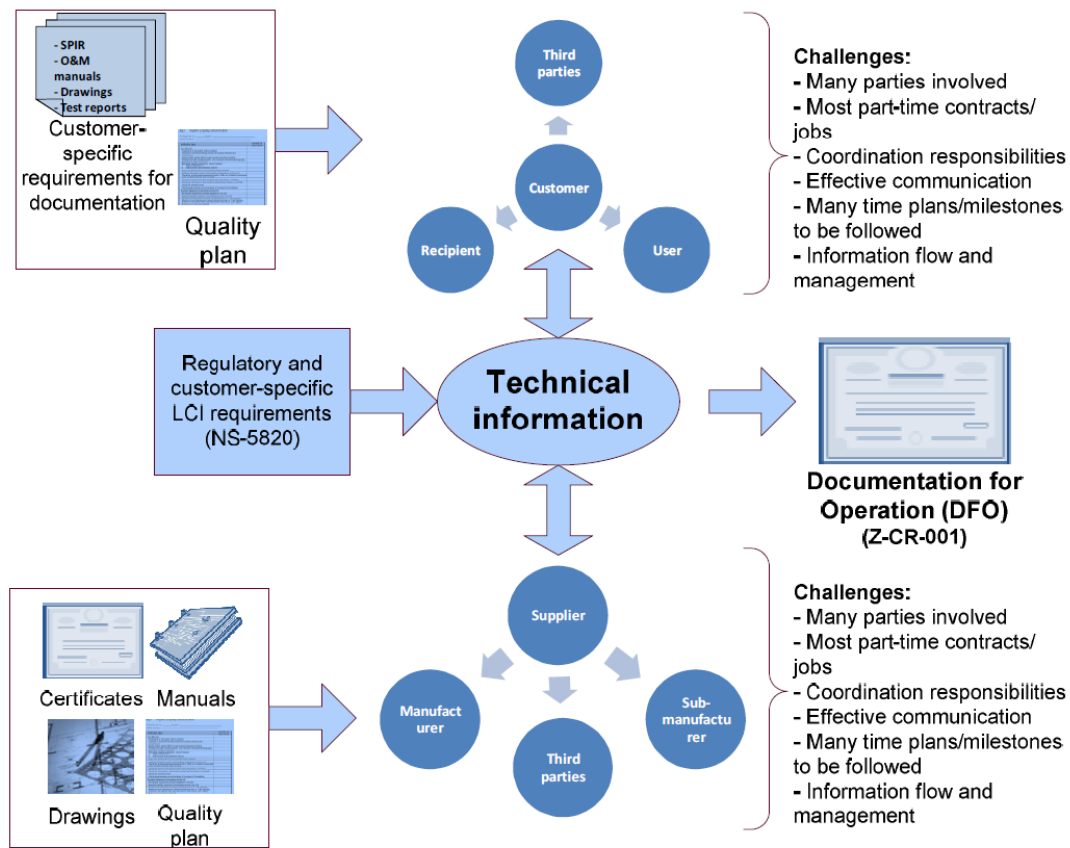
Figure 5-3: Technical data and information integrity (Raza & Ratnayake, 2012)

5.7 Tags and Tag-related Technical Information Quality Challenges

When the research discusses tags and tag-related information, the researcher means P&IDs, single line diagram, data sheets, data for HSE, drawings and O&M manuals, EX-certifications, and system control diagrams etc.

As mentioned and discussed previously, tags and tag-related information should be available before the completion phase, as all data should be in its As-Built status before starting the phase that is considered as a testing phase for the readiness of the facilities and assets used in the production. Any delay in delivering such information will affect the project time schedule and cost and companies will go through delay scenarios which are considered as a nightmare for all companies.

Quality of tags and tag-related information affects project deliveries and should be validated and assured by companies involved in MMO and EPCIC projects as all of this information will be the basis of the data base (master register). This register is considered as a main input for computerized maintenance management system. Master register is a tag database where all tags are kept with references to all information related to them. (CMMS) (Raza & Ratnayake, 2012).

The quality of maintenance management of the asset can be at risk in case of any incomplete or wrong information entered into the master register. Such mistakes can result in various inconveniences such as double registration of tags, poor administration, deficiency in the

historical track of both new and existing tags, and lack of technical information. It was demonstrated that most of large and small O&G projects are challenged mainly because of the inadequacy of technical documentation (Raza & Ratnayake, 2012). This explains why many of the Norwegian companies fail to abide by the corporate LCI requirements and NORSOK requirements.

Engineers who work with tags and tag-related technical information through PEM are the best references who can mention and talk about quality challenges they struggle with while performing their engineering tasks in the engineering phase. The researcher himself has been enrolled in Risk based maintenance program (RCM) for one of the new production fields in the North Sea. The researcher will go through some of the quality considerations and issues related to tags and their technical information. The stream of information from different sources to different parties should be planned, and information needs of different parties should be addressed so companies can allocate resources to ensure the availability of critical information. This is one area where lean thinking concepts can be applied to improve the value of the lifecycle information in EPCIC and MMO projects.

In the next parts, the researcher will go through more detailed and specific quality challenges related to Tag's generation and management in EPCIC and MMO projects. The information provided is based on interviews and discussions with engineering and senior engineers who work with Tags and tag-related technical information in a daily basis.

5.7.1 Tags duplications/Double registration of tags

One of the major issues confronting many oil and gas companies, especially those who directly work with tags in EPCIC and MMO projects is that they gather information and data from multiple and different databases. Databases sources belong to different parties which are engaged in EPCIC and MMO projects. Tags are considered as the basis of design and many other activities during engineering phase. Therefore, poor quality of the generated tags will affect the whole project and will affect all the parties that use tags. Data has to be entered into multiple systems, and this is considered a time-consuming task which results in many mistakes and inconsistent data. The absence of IT tools which could control and minimize human errors causes many problems. Many companies use their staff to do a huge amount of manual work, this work is repeated hundreds of times, and the repetition of tasks can generate stress and cause human errors. This, consequently, minimizes the quality and reliability of data and requires more rework to avoid any further development of errors. The cost of rework increases as the projects go further. Thus, all mistakes have to be corrected as early as possible.

Companies invest much money on IT systems needs in projects. Integration and using one system to do most of the jobs is a vital issue in asset information management. The integration of systems or using one system may reduce the manual work required by employees and improve the efficiency and reliability of the processes of generating and managing tags.

3.7.2 Poor administration of tags

Tags take different statuses during life cycle of project. The status of tags reflects the overall status of project. For example, reserved tags mean that they are generated in a database based on feedback from suppliers who made a list of the tags required to build the equipment/asset. Suppliers follow the owner's engineering numbering system. All sequence numbers and function codes of tags are generated based on information and requirements they got from the owner/ contractor.

The process of tags management does not stop once tags are generated; a long process of administrating tags starts in order to have control over the changes of documentations during the engineering phase. The change of statuses should be followed and recorded in different areas and disciplines.
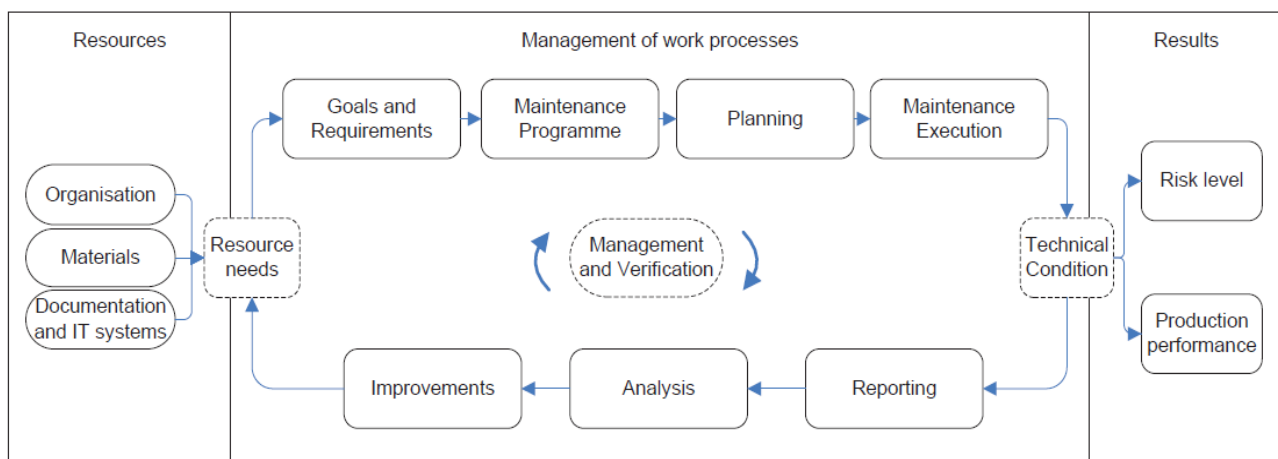

Figure 5 4: Maintenance Management Process. Source (NORSOK Z008, 2014)

The administration of tags in EPCIC and MMO projects is done usually by humans; companies use their resources to review and administrate tags and tag-related information, and this is considered as an inefficient way to manage the changes in tags and statuses during project development. We are talking about many parties and hundreds of changes done by different parties and people; this is why it is a challenging task to control and manage tags in large scale EPCIC and MMO projects. Humans cannot follow all the changes if they are not supported by a proper IT tool designed for this purpose. Tags generation and medication is something related to structured data processes where IT tools are very helpful and efficient. More details about a tool used by Apply Sørco customers will be discussed to show the importance of such tools in managing tags and tag-related technical information.

Tag administration processes include all activities required to administrate and manage tags once a tag is generated till it reaches its AS-built status. As-built status is considered as a requirement in NORSOK standards that has to be fulfilled and managed properly to measure the completeness and readiness of data during design phase. The more AS-built data available, the more tasks and milestones achieved. The proper and effective administration of

tags will improve the way companies manage its data to reach the final stage of engineering design and get all information in place before starting the completion phase.

Lack of historical tracks of tags is one of the main challenges facing people who work with tags. Systems should have the capability to maintain a historical record of data and tags changes. This is particularly of much importance when there is a need for old and historical data.

5.7.3   Other Challenges Related to Tag Management

Engineering companies that specialize in preparing maintenance planning activities and spare part evaluation makes use of tags and tag-related information as a basis for all work. The process starts when all tags from owner's database are imported into the engineering company's database. Information is not As-built and is subject to many changes due to design changes and incomplete data received from suppliers. P&IDs are considered as the raw data needed to accomplish most of maintenance engineering plans within risk based maintenance contracts. The figure below describes the maintenance management process during Risk Based Maintenance Process where documentation and IT systems are among the necessary resources needed to start activities related to maintenance management process.

NORSOK Z008 defines the documentation resources needed as all documentation required to carry out and manage maintenance in an efficient manner. Examples of these documentations are equipment/tag register, drawings and design details, historical maintenance data, maintenance task description, and spare lists.

Once the tags are received, the work start with preparing tag hierarchy where all tags are connected to their parent tags. This step is considered to be the main step of many other activities included in RBM contract. All the processes performed after this step is dependent on Tag hierarchy which cannot be performed and achieved without equipment/ tag register. The more ready tag register, the more the engineering company gets from owner, the more efficient work produced. The tag hierarchy achievement enables other engineers who work on different activities such as consequence analysis, spare part evaluation and maintenance planning to start their activities as planned in the project's schedule.

Absence and delay of information from owners and other suppliers would affect Risk based Maintenance project activities. The lack of information puts stress on the engineering company and makes the work inefficient and incomplete. The communication process among different parties is so vital and in case there is a good and a tight communication among suppliers, owner and engineering companies, the value added by different parties will be increased due to further availability of information. Some engineering companies ask for direct contact with suppliers to reach information and documentation they need to accomplish tasks they work on. This request would be avoided if the integration and communication among parties is planned. IT tools and Web portals are among the solutions that could minimize waiting time and enhance communication among parties during the engineering phase and other phases in the project lifecycle.

The researcher has had many conversations and discussions with engineers and senior maintenance engineers who perform most of these activities. Here is a summarized list of the challenges they experience during doing their projects' activities:

- Due to some errors by users who generate and administrate tags, it's common to find tags that do not follow the engineering numbering system of the company which is a regulation's requirement; this could be misleading and might affect the progress of maintenance planning.

- Missing tags is one of the common problems and challenges in EPCIC and MMO projects, this happens due to the update of drawings and documents during the engineering phase. Some tags can be found in the tags register which is used by the engineering company's staff without any link to documents or drawings in the owner database and system. Missing data is a challenge that has a significant impact on the project's progress. It's really hard to find some 100% accomplished tasks in maintenance and other design activities during the engineering phase due to lack of information and the update of drawings and other documentations.

- It is possible to find wrong tag-related information in documents due to some engineering and design mistakes or incompleteness of a design process. This can be misleading and requires more communication and contact to get right information or some feedback from the owner or supplier to avoid delays and bottleneck problems.

5.8   Equipment/Asset Technical hierarchies

NORSOK standard ZZ008 describes technical hierarchy as a corner stone in maintenance management. The technical hierarchy provides an overview of all equipment units that technically belong together. It shows the physical relationship between main equipment, instruments, valves, etc. The tag hierarchy should be established as early as possible to show all tags and equipment and the way they are connected to each other.

An equipment may be a component of a larger equipment/asset, area, process, system/subsystem, department, plant, and company. For example, an emergency stop button for a pump motor is a part of a motor which is a part of recompress condensate pump which functions in gas compressions system along with Gas scrubbers, coolers and other main equipment.

Tag/Asset hierarchies have great benefits. For instance, we can view all items above and below the tag hierarchy level; this quickly shows where the selected item fits into the large organization, and what the component elements are. Tag hierarchies also assist in providing a quick method to determine the physical location of an item. It gets easier for engineers and technicians to allocate any item by entering its tag number. Tag hierarchy may help in cost allocation as well. To explain in simpler words, the cost of repairing a motor can be linked to all levels above this motor instead of linking it only to the motor; tag hierarchy assists in automatically rolling up maintenance costs from the level in the hierarchy against which a work order was written to higher levels.

As mentioned earlier, tag hierarchy is a very important part of maintenance management. It can be argued that all RBM (Risk Based Maintenance) activities are dependent somehow on tag hierarchy. The percentage of work achieved will be directly affected the completeness of systems tag hierarchy.

NORSOK standard Z008 summarizes the purposes of technical hierarchy as follows:

- Technical hierarchy shows the technical dependencies of the installations
- Technical hierarchy assists in retrieval of tags, equipment and spare parts
- Technical hierarchy assists in retrieval of documents and drawings
- Tag hierarchy assists in retrieving historical maintenance data from CMMS
- Tag hierarchy helps in planning for operations
- Tag hierarchy helps in cost allocation
- Tag hierarchy has a great role in planning an organization of the maintenance program.
- Tag hierarchy assists in planning for corrective work (Corrective maintenance).

The purposes mentioned above will not be accomplished or fully accomplished if tags and tags hierarchy are not available. Tag availability and quality of their quality are among many factors which affect projects' all-over quality. The smooth flow of tags and tag-related information ensures that different parties working on different areas in projects will be able to produce the value their business area intends to provide within the whole supply chain of the project.

5.9   Management of Change

Information packages have two major properties regarding changes that occur to tags and tag-related technical information during the lifecycle of EPCIC and MMO projects. Status defines the exact versions of documentations and information related to tags required for handover. While type defines whether or not the tag related information and documentations should be modified after handover.

Tags and tag-related technical information statuses change throughout the project's different life cycle phases. For example, a drawing status may start as ''issued for comment'' and might be later changed to ''issued for construction'' after a review by an authorized person, and finally it it will be updated to ''As-built'' status. Companies should define the status terms to be used; this is considered as an initial standardizations step (Fallon & Palmer, 2005). The status of tag follows the status of documentations and should be managed and administrated effectively to improve information quality.
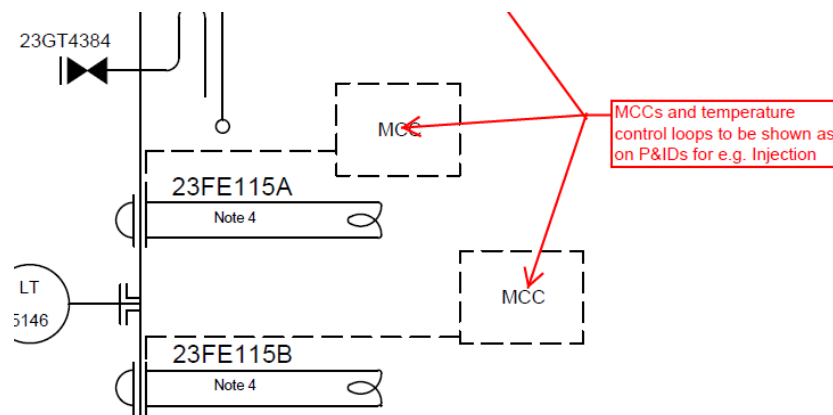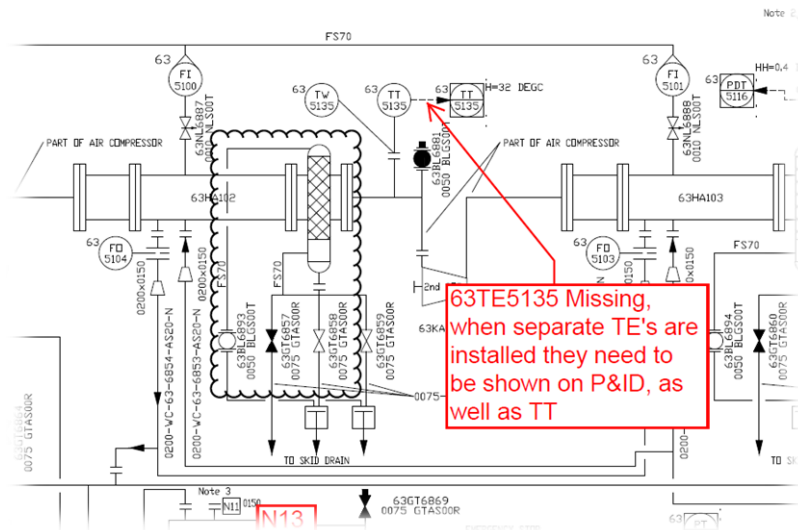

Figure 5-4: P&IDs need to be modified due to some design changes, not As-Built

The management of changes to plant configuration is essential to both effective working and the technical integrity of a facility and its related plant information. Effective change management is important through all phases of a facility's lifecycle, but is most acute during the project development phase (engineering phase) where thousands of changes need to be administered, hundreds of which may be "live" at any one time (Intergraph, 2007).

On the importance of change management Bjorn Henrik Magnus, Statoil PIM Advisor who was the project manager who led a workgroup in January 1997 for the implementation of a data warehouse for managing the plant life-cycle information for Åsgard B, the largest floating gas platform in the world, he commented: "During detail plant design, 50% of the engineering work performed is the result of changes and this rises to 100% after the Approved for Construction milestone during the "Follow-on" engineering phase. Over 4000 changes have been registered for the Åsgard B project. Traditionally, paper driven or simple electronic archive systems do not allow users to get a satisfactory overview of changes and their status and what "is in the pipeline", neither do they allow adequate traceability over what changes have affected plant items."

Managing changes is always costly and time-consuming due to the complex interrelationships that exist between the affected plant items, the data and documents, and the work disciplines and companies. A further complexity is the "ripple" effect that one change has on others. The PIM Change Manager tracks the details and status of each change, highlights plant items subject to ongoing change, provides an overview of all changes affecting a plant item, and manages the workflow for all changes and mark-ups. PIM Change Manager offers the benefits of an improved overview of changes and their status, simplified handling of changes, improved planning of change implementation, reduced costs and improved traceability of changes (Intergraph, 2007).

This section addressed the importance of applying information technology solutions to control the flow of information among all parties involved in EPCIC and MMO projects. Åsgard B project is a clear example of the benefits earned from using integrated IT tools to manage data during the lifecycle of EPCIC and MMO projects. Statoil and Intergraph (IT solutions Provider) have established a close e-Engineering business partnership. E-Engineering addresses access, management and administration of technical plant information in all main work processes in development projects, and on into operations. This partnership formed a joint integrated e-Engineering team to drive the successful development and implementation of a web enabled, standards-based Plant Information Management (PIM) data warehouse to hold all technical as-built data, originally for the Åsgard Offshore Project. Bjørn Henrik Magnus said, " It previously cost Statoil between US$500 - 1,000 to revise a single drawing with Change Manager the company has reduced this cost to 10% (US$50-100). It improves the change impact planning and change implementation, with consequent lower costs. The big advantage is that it provides management with an improved overview of changes and their status. The savings in this area alone would justify the system expenditure for PIM." (Intergraph, 2007).

Table below shows some information about the number of tags, changes that take place during the engineering phase; numbers are used to illustrate the challenges of managing tags and tag-related information in project development of new fields.

System users	**500**
Users working concurrently	40-60
Number of manufacturers	305
Number of tags	120000
Number of drawings and documents	60000

Table 5-1: Tags, system users and tag related information in a green field development Project

Chapter 6 - Tag Management Application: Tag Manager

6.1   Introduction

The research has previously examined tag management and administration challenges oil and gas companies face during EPCIC and MMO projects. The complexity of work processes, the need to manage changes of information and revisions, and the need to coordinate information flow among parties involved in activities during PEM make it a must for contractors and owner to adopt and use robust technological solutions.

To bridge the technical gaps of managing information flow and to ensure a smooth and a reliable flow of information among different parties during PEM, latest information technology solutions/tools are combined with traditional project engineering/management to support asset management teams and project staff.

IT solution providers should have a proven knowledge about activities EPCIC and MMO projects in order to provide solutions which are directed towards clients' needs. An efficient solution for tag and tag-related technical information management that ensures effective delivery of quality data at the right time and to the right people is reliant on the optimum integration of technology, people and processes which are considered to be the essential components of data and information management.

When data management processes, best practices, data management technology combined with data management service people, efficient data flow is ensured. Technical workflow which is considered as the logic behind the flow of activities through processes, end user applications (web-access) and the end users are the main parts included in the work flow. All the aforementioned elements are brought together by information management solutions. To summarize, engineers establish processes, use technology to access data, extract information, drive best practices, convert all into decisions, drive value, and add all to the knowledge base.

In the recent years, it became very essential to integrate software with the core activities in oil and gas industry. Particular Software supported and aided activities of different project teams, ranging from data storage, interpretation, modelling, analysis, decision making and evaluation.

Software products have evolved over the last few years ranging from client server application, web application, and portal solution (as the TAG manager provided as a supportive tool to one of APPLY Sørco Asset integrity services clients in modification projects). The software used is selected based on the functional requirement of various project groups in oil and gas activities.

This chapter will map and discuss the capabilities of web-based application (TAG manager) in administrating tags and managing tag-related technical information through project execution. It will also go through some of potential improvement opportunities based on a feedback, interviews and experience sharing from TAG manager users.

6.2 Tag Manager

Before elaborating on the Tag manager, based on information gathered from experienced engineers and by means of research, tag management can be defined as:

The efficient control and follow up of asset identifiers/identity numbers (Tags) and tag-related technical information. It starts with tags generation, passes to the different statuses a tag acquires, and ends up with the As-built status of a tag. It helps PEM to achieve a smooth and optimum flow of information to ensure quality and availability of data to different parties involved in modification project.

Asset management services department in Apply Sørco has developed and provided a web-based software that provides an opportunity to manage tags and the flow of tag-related technical information during project execution model. Tag manager was built to support clients in making their activities compliant with the regulatory requirements and norms. It also provides the client with the flexibility and control needed to manage and administrate tags and tag-related information in small and large scale modification projects (Raza & Ratnayake, 2012).

The drilling company which uses tag manager to manage and administrate tags and tag-related information has different projects with operator companies offshore. It is known that most rigs operate 24 hours per day, 7 days per week. Rig crews work 8 or 12 hours shifts. This means maintenance and modification activities are vital to ensure work continuity and to avoid downtimes cost. Machines and assets which work long hours will fail or give indication about a close failure. Dealing with aging assets is a vital issue as well. Decisions to change an asset or a part of a system are something common in drilling rigs. Modification projects that take place offshore range from small ones to large projects where more activities and plans are needed. Tag manger ensures that modification projects are done effectively, and all activities related to tags and tag-related technical information is under control.

Tag manager comes as a solution that provides a master tag register with references to tag-related technical information. It can be used by the drilling company engineering staff and operator's staff as well. Tag manager's main objective is to solve the challenges that face project teams during project execution model.

Tag manager was initially deployed on some brownfields projects/rigs, and soon it was deployed to many rigs. Tag manager has the flexibility to be upgraded and used in a variety of projects and scenarios such as: Brownfield, Greenfield, Onshore, Offshore, Feed, and detail engineering projects.

It is known that management of information and documentation for manufacturer's standard equipment such as instruments, lighting fittings, junction boxes, cables. Electric motors, etc. within the process industry has been poor (Intergraph, 2007). Time and money through the value chain are being wasted due to lack of proper and effective management of tag and tag-related technical information; datasheets are entered into database many times due to repeated submission of suppliers. This, in turn, affects the data quality by increasing the number of multiple copies of same data. Tag manager is an effective tool to coordinate activities during modification projects as it controls all the flow of information and eliminates the duplication

problem. The next section will go through the expected features of tag manager and the results of deploying this IT tool to some projects and rigs.

6.3   Tag Manager main features and capabilities

Tag manager is a web-based portal that works as a helping tool in managing lifecycle information in modification projects. The tool has no direct link to the company's CMMS, but the flexibility of the application makes it possible to ingrate it with the drilling company's CMMS. It is worth reminding that tag manager is a tool designed to support the lifecycle information management through providing a controlled process to generate and maintain/administrate tags during modification projects. Every tag has its own information and documentations that need to be managed properly. The technical information related to tag is very vital and considered as the backbone of all engineering activities during project life cycle. Tag manager has no direct link to company's documentation systems like SAP, but still has the capability to be integrated to support documentation's management. Drilling company staff is responsible for quality assurance of documentations. Document control unit works to review and check data and revisions before letting the document into the company's documentation's database. Tag manager provides support to these people through controlling the handover of supplier's documentations.

Here are some of the main features and capabilities of tag manager as described by (Raza & Ratnayake, 2012).

- Tag statuses are updated based on drilling company's PEM defined milestones. Tag's status changes during project execution, the change defines the documentation readiness and information completeness.

- Master tag register is updated automatically with relevant technical information and tag statuses change during PEM.

- Reusable and Standardized data: Reserved Tags are deleted automatically so they can be reused in future projects.

- The system keeps history of all tags in a manner that there is minimum number of unused tags left in the master register.

- Tag manager has the ability to keep its database clean and updated; all obsolete and unused tags are deleted.

- Tag manager supports standardizing tag management process on many installations globally and locally .

- Tag manager has multiple levels of user access including read-only, write and administrator level; this ensures the integrity and quality of the tag database.

- Tag manager has the ability to save logs history to track users' actions when needed.

- Tag manger is built with a common mail box to maintain a communication channel related to data flow between suppliers and drilling company. The main box is very efficient in providing data on time.

- Integrated module capabilities including tag and functional hierarchy and criticality evaluation.
- TAG Manager System keeps predefined reporting features for ease of generating reports for review/audit purposes. User logs are automatically generated and available as per needs lists all major actions performed by different users.

Tag manager has the flexibility to be customized to meet customer requirements, and there is a great potential to improve the application to cover other areas or to enhance its functionality. A survey and interviews have been held with tag manger users to figure the main benefits of the application. It is to be noted that the application is in its first phase of development and a second phase of upgrade and modification will be done when necessary.

One of the thesis sub-objectives is to make suggestions and guidelines for possible improvements, modifications and updates that could be performed on tag manager. The results of the survey will be used to achieve this objective.

6.4   Tag management Process during modification's PEM

During the FEED study of modification project, all the options and alternatives are discussed. Feasibility studies and experienced engineers show that there will be a need to change some equipment, replace an aged system or upgrade a system/equipment in case of availability of a new technology.

The complexity of project depends on its scale; managing a small scale modification project where the number of tags is limited is much easier than changing a whole system where generating many new tags and manning their technical information will be required. The drilling company used excel sheets as a communication tool with suppliers and all other activities were performed manually by different team's members.

One of the main objectives of using Tag manager is to identify and specify the role of the drilling company and the suppliers in successful execution of modification model (Raza & Ratnayake, 2012). Tag manager is an IT tool that has constrains that assures data quality requirements are achieved. Everything is controlled and works in a systematic manner. Tag manager is aligned with PEM and is based on five simple functional steps. Effective coordination between all involved parties (Project responsible, LCI coordinator, suppliers) is required in every step..
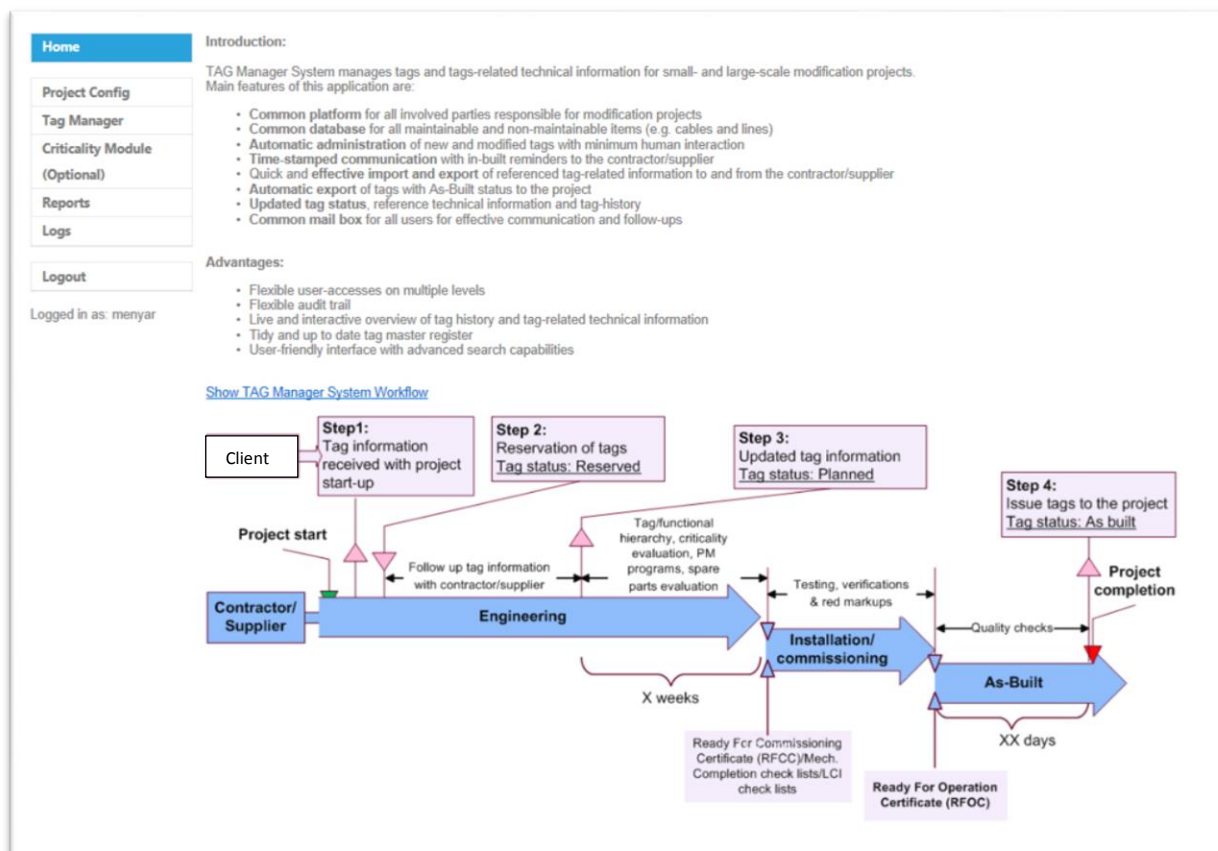

Figure 6-1: Tag Manager Home Screen

The 5 steps are described below:

6.4.1 Sending a request to supplier using Tag manager

The process of managing tags and tag-related information starts when the drilling company sends a request to one of the suppliers using Tag manager. Tag manager has the capability to send necessary documents directly to suppliers. The request is sent per tag category which can be selected and identified from Tag manager.

6.4.2 Tags Reservation

Upon supplier's request, tag manager starts reserving tags with assigned sequence number; this sequence number is found based on availability in master tag-register with minimum human intervention (Raza & Ratnayake, 2012). The tags reserved (per tag category) are sent back to the suppler. Tag's excel files received from suppliers will form the basis for data collection of tag information, check marks on P&IDs and documents, as well as the physical tag signs offshore. The drilling company defined some colours to distinguish between the columns that should be filled and completed by suppliers and the ones the drilling company needs to fill. The status of files and tags in this stage will be RESERVED and the revision number will be one.

Tag sequence numbers which are generated by tag manager are marked in blue in the examples below. The drilling company Staff used to search for sequence number manually. Tag manager finds the available sequence number related to the category with minimum human intervention.

Project nr. /PO. Nr. Given.

TAG category1: 2 Items. 721-FE-XXX, 1 Item. 721-PA-XXX, 1 i 733-PS-XXX
Tag category 2 : 3 Item. 10"-761LXXX-BR42-4
Tag category 3 : 10 Item. 761-BU-XXX
Tag category 4 : 5 Item. 361-I-PSL-XXX-A
Tag category 5 : 3 Item. AA-875-EL06-XXX-12
Tag category 6 : 4 Item. CM-N-733-XXX-A

The drilling company staff will fill areas marked in blue.

Figure 6-2: Tag reservation, sequence number reservation

6.4.2 Tag status update during PEM (Managing change on documentations and tags)

The status of tags will be Planned when the projects approaches the end of the engineering phase. All reserved tags which were not used during engineering phase will be left by the suppliers. Tag-related information is automatically updated. The quality of information is checked and assured by disciplines that control the flow of information prior to proceeding ahead with the projects. It should be noted that information flow between the drilling company and suppliers is a continuous process with many updates and revisions.

6.4.3 Managing revised and deleted tags

Tag manager is designed to handle and work with different tags' statuses. It is possible to reuse some tags in the project, and tag manager has the capability to handle them. When suppliers send request to delete, or to revise some tags, tag manager flags these tags with relevant status. We should mention that tag manager does not delete any tag; no tag is physically deleted from tag manager's database, tags are kept in case some parties need to track the history of tags.

6.4.4 Project Completion

During installation phase and no later than 14 days before the handover to operations (RFOC), all lists must be sent back to the drilling company completed. All tags that are used in the project should be marked as PLNANNED. The information which comes under the responsibility of the drilling company should be updated.

When RFOC certificate is signed, the supplier has 30 days to update all LCI to As-Built status. All tag numbers shall be marked with the correct code in all relevant As-Built drawings and documents used in the project SOW. Suppliers send files to the drilling company one last time before the deadline to track any data corrections in the As-built stage. In addition, all PLANNED tags used in the project should be marked AS-BUILT.

Tag-related information is considered a significant part of LCI documentation, and form the basis of key internal processes in Drilling Company such as: preventive maintenance program, criticality classification, and spare parts evaluation. It is worth a remark that this information should be in place before the project is formally handed over to operation (RFOC).

It's worth mentioning that all process activities were performed manually, and there was a huge potential for errors as there was a need to enter data by drilling company's staff and by supplier's staff as well. Tags might be duplicated and there were no clear defined procedures to assure quality of tags and tag-related information. It also a time consuming process for users to find the available sequence number and they had to assure that this

sequence is not used. Tag manager was developed to bridge these gaps and to eliminate manual work which is considered as a source of errors and inconsistency.
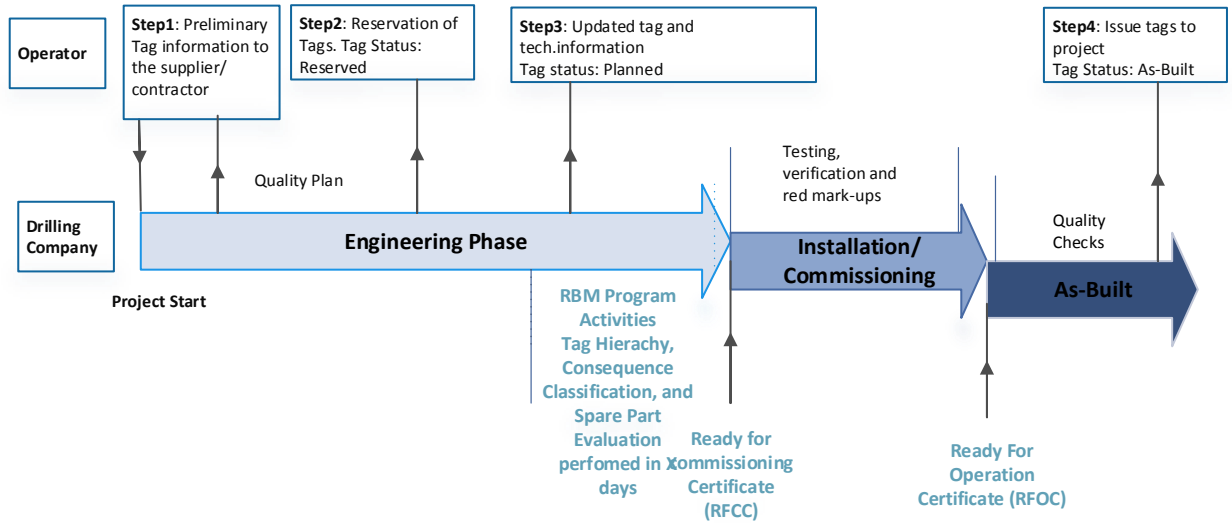
Figure 6-3: TAG Manager System integrated with modification project execution model (Raza & Ratnayake, 2012)

6.5 Customization and preparation of Tag manager

It's recommended to start using Tag manager once the modification projects starts. The control tag and tag-related technical information will be more efficient if Tag manager is used as early as possible in the modification project.

Prior to using Tag manager, all database and relevant existing tag and tag-related technical information need to be imported into tag manager database (Raza & Ratnayake, 2012). Tag manager is flexible enough to be integrated with other management and maintenance systems in this phase, the opportunity to achieve this task is discussed with customer and the benefits are described. Data integrity will be improved in case of integrating Tag manager with other maintenance and management systems.

Excel sheets which will be used as a communication tool between suppliers and the Drilling Company are also prepared based on tag categories which describe the different assets and equipment needed during modification project. Engineering Numbering System manual is also used to establish the codes and tags formats needed during tag generation process.

Preparation
- Database related to tags and tag-technical information is imported.
- Tag master-register where all tags will be stored is established.
- Tag manager can be integrated with client's maintenance and management systems (As required by client).

Customization
- Tag manager is being customized as per client's requirements
- Client's ENS manual is used to establish client's tag format
- Aligning and customization Tag manager as per client's PEM

Implementation
- Start using and implementation tag manager in modification Project.
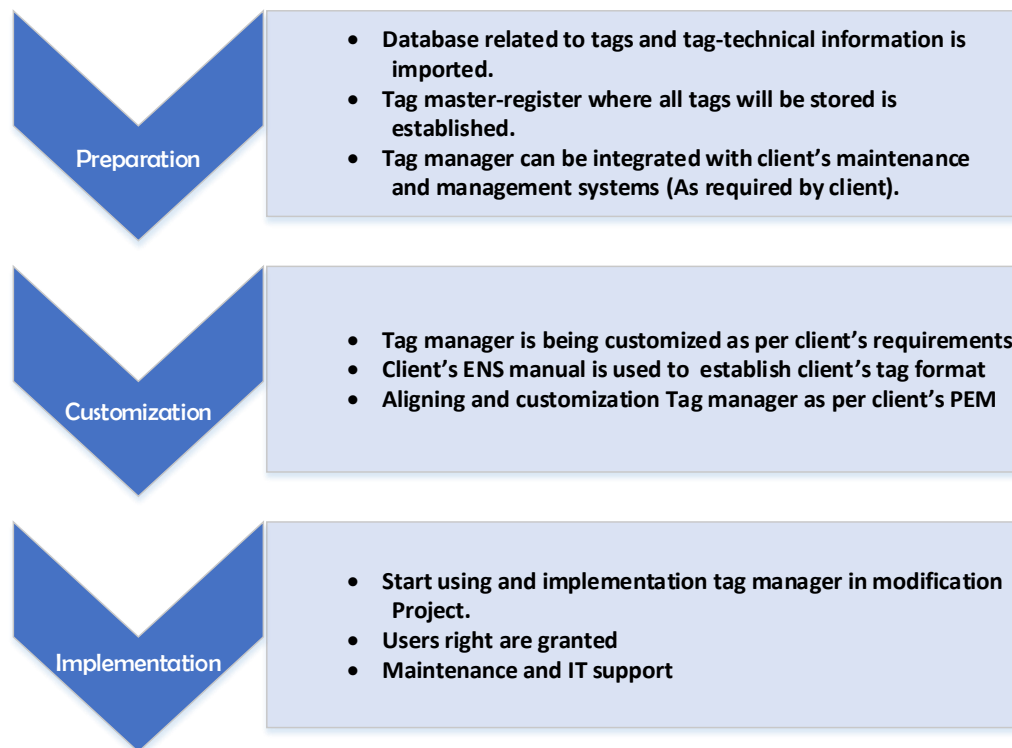- Users right are granted
- Maintenance and IT support

Figure 6-4: Tag manager customization and preparation

Chapter 7 - TAG Management Process/Software Application Questionnaire/Case Study

7.1   Preface

As mentioned earlier, Tag manager has been in use by Drilling Company since 2011. A questionnaire was prepared as a part of this master thesis to measure the performance of the application through interviews with some users of Tag manager.

This questionnaire is built based on the literature review and experience sharing interviews with engineers who work in related fields.

Five Engineers from three different companies participated and took part in the questionnaire:

- Three maintenance engineers, including one senior maintenance engineer, who work for the drilling company and use Tag manager.

- A discipline maintenance engineer who participated in Tag manager project from the beginning. He works for Apply Sørco.

- A maintenance engineer who works for Apply Sørco and uses Tag manager.

- An engineer who works for Apply Rigs and Modules and uses the Excel files generated by Tag manager. He works as a contractor and supplier of many parts to Drilling company

The interview with the engineers from Drilling Company lasted for thirty minutes due to their busy schedule. Some respondents completed an online version of the questionnaire due to their unavailability.

It was agreed that information, data and names used in the questionnaire and in the master thesis will be confidential and nothing will be presented publicly.

7.2   Tag Manger Questionnaire

Five metrics were chosen to measure the performance of Tag manager. The metrics are predefined and based on drilling company's need to have such an IT tool to manage tag and tag–related information in modification projects. The researcher used the information he gathered in experience sharing meetings and, in addition to the information he managed to collect and analyse in the literature review section to prepare a questionnaire that covers the different areas. Tag manager is aligned with the drilling company's PEM; it's not just an IT tool that handles information; tag manager is built based on project engineering concept which controls and manages tag and tag technical information during PEM.

It should be mentioned here that there were not many participants in this survey as Tag manager is not a commercial IT tool; it is designed to support and facilitate tag and tag-related information in modification projects.

The metrics used to measure the performance of Tag manager are:

- **Information Integrity:** a part of the questionnaire was about the value added by Tag manager to information integrity during modification projects. This area includes questions related to the communication among different parties, concurrent engineering, tags and tag-related technical information flow, tags and tag-related information availability, meeting project deliverables on time and at cost, understanding the system functionality and statuses of tags during project, handling old tag-related information and the importance of integrating tag manager with other systems used by Drilling company.

- **Quality achievements:** in this part, questions are related to data quality and value added by tag manager during modification projects. The questions' objective was to measure how Tag manager helped Drilling Company to improve the overall quality of project deliverables through providing data with satisfactory quality. It also measures how Tag manager improved the quality through minimizing manual work done by Drilling company's staff.

- **Cost and savings:** The drilling company's staff performed all the actions needed to generate and manage tags and tag-related information during modification projects. A question of spatial scale was built to get feedback about achieving cost savings after implementing tag manager.

- **Compliance with Norwegian standards and regulations:** There are some regulations and standards that regulate information management to enhance information integrity in oil and gas PECIC and modification projects. Some questions related to the Tags and tag-related technical information compliance with Norwegian regulations was used to demonstrate the conformity and compliance with these regulations.

- **User Interface:** Questions related to user interface and the ease of use were asked to measure the performance of Tag manager. Questions were related to system speed,

system functionality, bugs and errors, working with excel sheets, crash ad freeze problems, software layout, etc.

7.3   Questionnaire results

The metrics which were chosen to measure the performance and efficiency of Tag manager in managing and administrating tag and tag-related information in modification projects will be presented via graphical charts. The researcher will examine some points and results he collected during interviews with the engineers.

7.3.1   Information Integrity

The chart below illustrates the results of the five respondents who participated in the questionnaire. The results range from zero to five as indicated in the grading scale below. The length of the bar represents the score of each target area related to information integrity. The areas are summarized in table () and questions related to each area can be found in Appendix A. The highest scores were given to the areas where Tag manager provided support to controlling Tag and tag-related information management process which has a great impact on information integrity.
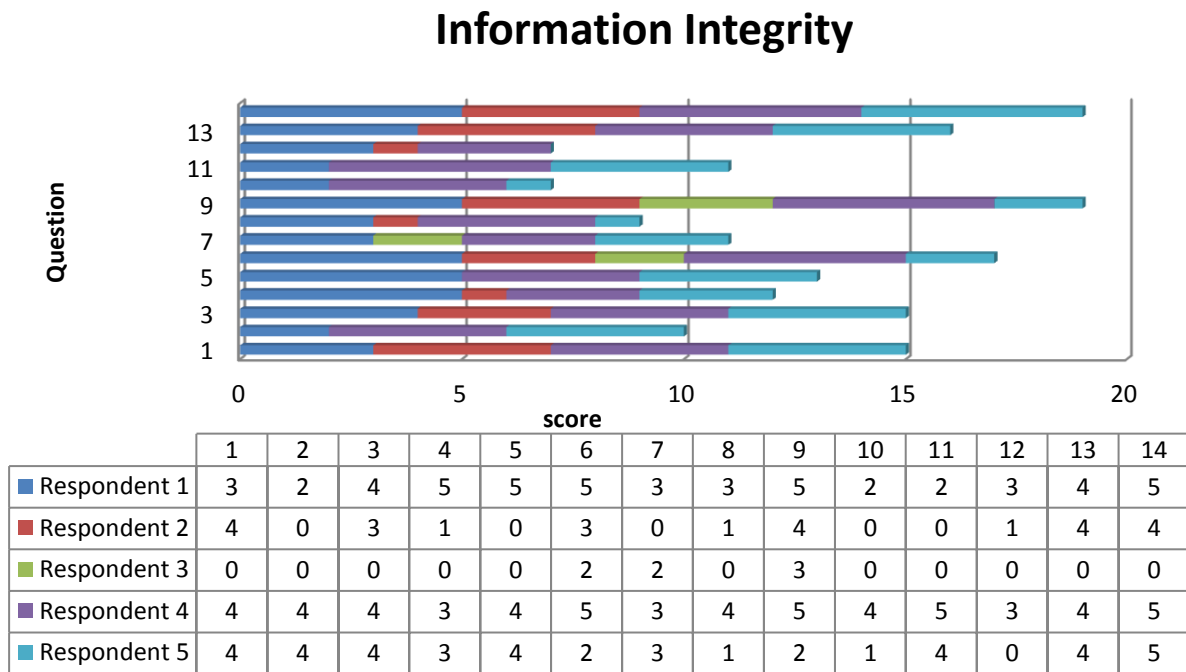

Information Integrity

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Respondent 1	3	2	4	5	5	5	3	3	5	2	2	3	4	5
Respondent 2	4	0	3	1	0	3	0	1	4	0	0	1	4	4
Respondent 3	0	0	0	0	0	2	2	0	3	0	0	0	0	0
Respondent 4	4	4	4	3	4	5	3	4	5	4	5	3	4	5
Respondent 5	4	4	4	3	4	2	3	1	2	1	4	0	4	5

Figure 7-1: Tag manager assessment. Information Integrity

Scale	0	1	2	3	4	5
Definition		Strongly Disagree	Disagree	Neither free nor disagree	Agree	Strongly Agree

Table 7-1: Grading Scale 0 -5

The average responses of information integrity for the five engineers who were involved in the questionnaire are represented in figure (). The figure represents the average rating of areas investigated in the information integrity questions in the questionnaire. The figure indicates that almost all areas have a satisfying grade. Low ratings between zero and three are due to the absence of integration between tag manger and other systems used by the drilling company such as SAP and ONIX; these low ratings can be considered as a potential for improvements and integration between other tools used by the drilling company.
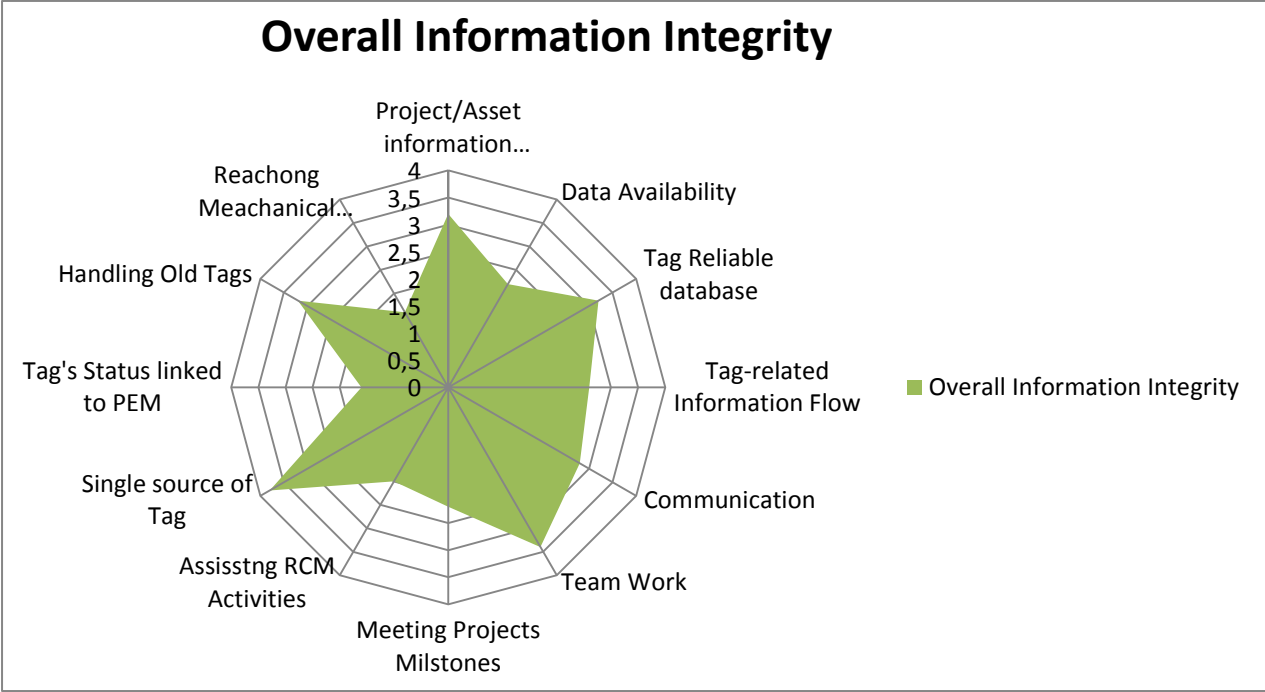

Figure 7-2: Overall Information Integrity Chart

7.3.2 Information Integrity Summary and Questionnaire results

All engineers the researcher interviewed agreed that Tag manager has a significant role in improving information integrity in modification projects. Here are some points which summarize the interviews with the five engineers.

- Despite the fact that Tag manager is built to handle a big number of tags; much more than the tags being used in projects performed by the Drilling Company, it still has great benefits in managing tags and tag-related information in small re-building projects executed by the Drilling Company.

- TAG manager provides a potential for adding value by sharing information which resulted in enabling parties to contribute to an existing base of information. This is not fully implemented right now, but work is undertaken in the hope of fully achieving it.

- The engineers agreed that there is a need to integrate Tag manager with other systems used by the drilling company to improve information integration and data quality. Tag manager should communicate with maintenance management system (CMMS) as the Drilling Company uses ONIX. Benefits will be maximized if it communicates with SAP and ProArc.

- It was clear that TAG manager implementation resulted in a better teamwork and a smooth flow of data and information among different parties involved in projects.

- One of the senior engineers mentioned that Tag manager provided a tool to have control over all the activities performed once purchasing orders are sent to suppliers. Tag manager provides many features which enable the drilling company to know who performed a specific task and when the task has been performed.

- Tag manager reminder feature, if properly used, could eliminate any delays from the supplier side. The suppliers will be notified about the date on which tags and tag-related information should be sent to the Drilling Company.

- Improved capabilities in assisting the drilling company in execution modification projects via providing optimized and controlled engineering work processes for managing tags and tag-related technical information in modification projects. Tag manager is built in alignment with the modification project, the company's project execution model (PEM), and is in compliance with Norwegian legislations (§ 13 Work processes).

- Manager tag associates engineering information and cross-references it to related documents, thereby helping to achieve information integrity. Information and data flow from suppliers and to them are controlled, managed and referenced with a dynamic reference that direct users to documents in company's documentation system or CMMS.

- TAG manager approved its efficiency and ability in handling old tags which were not generated according to Tags regulations, this included changing tags and keeping relevant data in TAG manager database.

- Support of concurrent work using common information. The web portal application makes it possible for many users to work on data they need. Value can be added from different sources due to availability of information they need. This could be a great benefit to corrections or feedback and communication among parties.

- Tag manager has the flexibility to be integrated with other management systems such as: SAP and CMMS. This is considered as a very important issue in supporting and improving asset life cycle information integrity.

- TAG manager has a positive effect on meeting the deliverables and reaching projects milestones.

- TAG manager provides a reliable and efficient database for consequence classification, maintenance planning and preventive maintenance activities, and spare parts evaluation, in compliance with Z008.

7.4 Tag and tag-related information Quality

Figure () below illustrates the data quality results. The data are graded from one to five as indicated in the grading scale below the graph.

The questions investigated Tag manager efficiency in improving data quality through modification projects. High scores were given to Tag manager contribution in improving projects' overall data quality through providing a reliable and updated tags and reference to tag-related information. It also improved tags quality through reducing manual work required to generate tags.
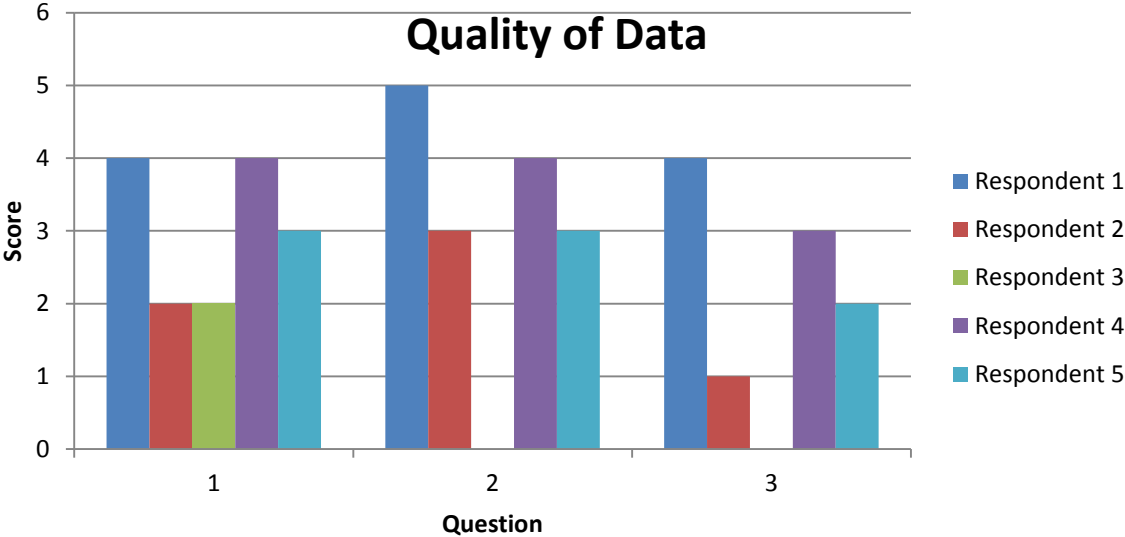

Figure: Tag manager Assessment. Information Quality

Scale	0	1	2	3	4	5
Definition		Strongly Disagree	Disagree	Neither free nor disagree	Agree	Strongly Agree

Figure 7-3: Grading Scale 0 -5

7.4.1 Data Quality Summary

- As stated earlier when tag manager features and capabilities were discussed, most of manual work was minimized. This had a great effect on minimizing human errors. Two engineers mentioned that Tag manager eliminated tag's duplication which was one of the problems.

- Single point of data entry; this comes as a great feature as it eliminates doubled tags and helps in minimizing work stress by removing stress factor of doing same things again and again.

- Improved accuracy and quality. TAG manager assists Drilling Company to improve projects' overall quality through providing reliable and up-to-date tags and tag-related referenced information.

- Improvements in efficiency and decision making resulting from better information availability, quality, and security.

7.5 Tag and tag-related information regulations compliance

The figure below shows the responses of the five engineers who participated in the questionnaire. The Average for rating grades is plotted from 0 to 5. The length of the bar shows the average score for the five participants.
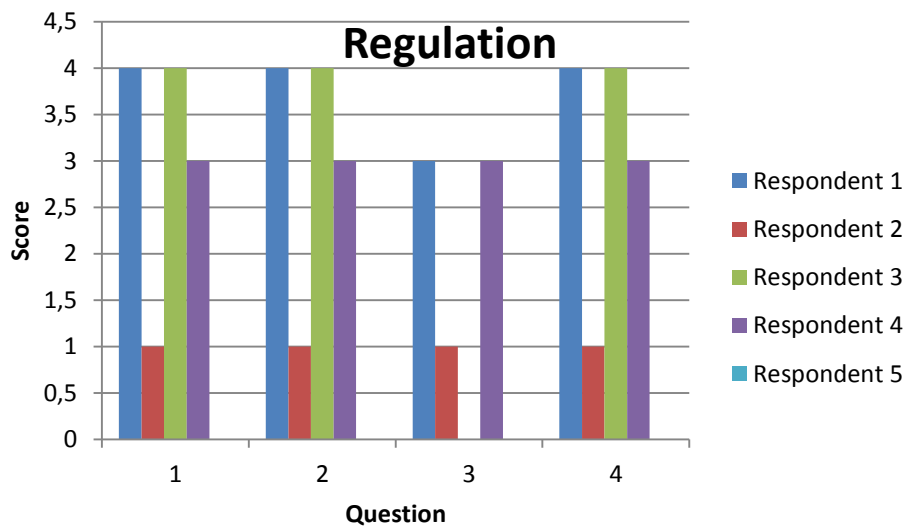

Figure 7-4: Tag manager Assessment. Regulation and Compliance

Scale	0	1	2	3	4	5
Definition		Strongly Disagree	Disagree	Neither free nor disagree	Agree	Strongly Agree

Table 7-2 Grading Scale 0 -5

The researcher studied Norwegian Standards and regulations related to information management in EPCIC and MMO projects. Tag manager complies with the regulation that states that the Drilling Company should ensure that information is acquired, processed and communicated to relevant users at the right time.

Tag manager has also a role in managing As-Built data. All tags get As-Built status before reaching the completion / installation phase. It also helps in ensuring that all data has one source and one responsible owner. Tag manager supports concurrent engineering concept which is among the Norwegian regulations related to lifecycle information.

7.6   Tag and tag-related information – User Interface

The figure below shows the response related to user interface and ease of use. The questions where about twelve, and the length of the bar shows the score of each question for the five engineers who participated in the survey. The questions can be found in Appendix A.
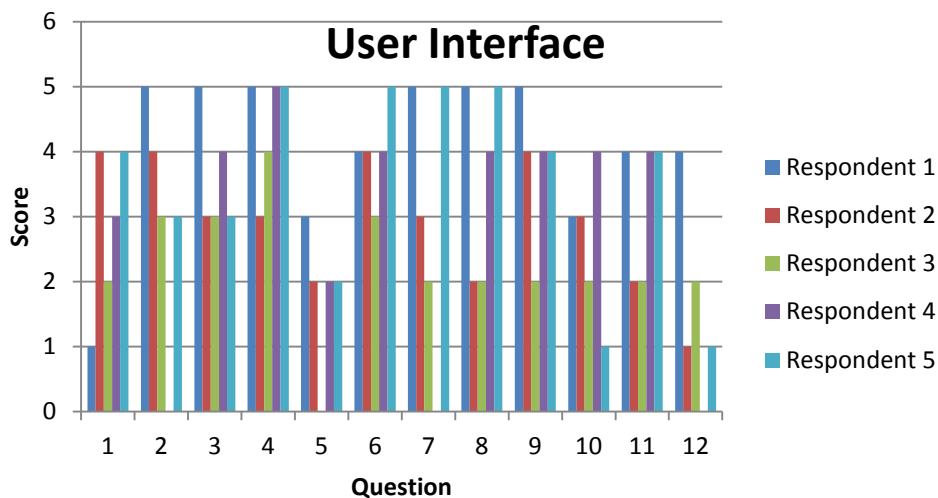

Figure 7-5: Tag manager Assessment. Regulation and Compliance

7.6.1   User interface Summary:

The researcher has received a good feedback regarding Tag manager user interface. The system meets the Drilling Company requirements and expectations; however, many improvements can still be done in this regard. The research addresses potential improvements in the next chapter.

Some of the points received during the interviews with different users can be summarized as follows

- It was easy to learn how to operate Tag manager and understand its different functions.

- Bugs are not frequent and the system is reliable, but it more feels like Tag manager is an underdeveloped system. The explanation for this is that Tag manager is in its first stage, and there is a potential for improvements and upgrades based on the Drilling Company's feedback and requirements.

- Importing and exporting excel files from and to tag manager is an easy task, but users experience system slowness when they work with heavy files. Most of the projects and tasks executed by Drilling Company are small re-builds, and users do not

experience this issue so often. The system can be upgraded and optimized to handle the heavy loading and uploading heavy Excel files.

- The system has a satisfactory layout/design with good allocation of buttons.

- System users barley experience system crashes or freeze.

7.7 Cost and savings

Tag manager has great features which enable the company to have control over tags and tag-related information during the projects they perform. Drilling company engineers mentioned that the value added by Tag manager is more relative do the control of information and not directly to cost. Most of projects performed by drilling company are small projects (re-builds) with limited number of tags.

Tag manager assists Drilling Company to avoid duplicates that could be a source of bottlenecks problems and quality gaps where rework and correction actions are needed.

Tag manager is designed to handle big number of tags; the system efficiency is more visible in large medication projects where major changes and upgrades are needed.

Tag manager helps minimize human work required in tag management process where staff had to search for latest available sequence numbers; this process is time-consuming in case there is a need to add a huge number of tags.

Tag generating and the follow up of tag's changes during modification projects were done by suppliers, and this would benefit Drilling Company in providing suppliers (considered as partners in the model supply chain) with efficient tools to improve their deliveries' quality.

One of the engineers who use Tag manager gave some approximations about Tag manager's role in reducing man-hours spent on changing and updating tags.

	Excel/ CMMS	Tag Manager
1 Change/Update	1 min	30 sec, time to upload excel file.
100 Change/Update	10 min	1min, time to upload excel file.
1000 Change/Update	1 hrs	1min, time to upload excel file

Table 7-3: Tag manager role in reducing man-hours

A different grading scale was used to measure the cost and saving after implementing Tag manager. The engineers agreed that Tag manager has reduced cost by 0% – 25%. This reduction is due to automating many tasks that were done manually.

7.8   Further Discussion

Figure () describes the overall representation of Tag manger's performance indicators used in the evaluation questionnaire. The overall average grades are plotted to each area of the five areas approached by the questionnaire. It is clear that information integrity which includes the process forming the logic and the control behind tag manager has a satisfactory grade. This reflects the positive changes achieved after using Tag manager.

Tag and tag-related information quality is what is meant by data quality. Tag manager has no direct impact on data quality, but it helps to have control over the flow of tag-related information which supports data quality and availability. Tag manager controls the revisions where changes are done and keeps a record of tags history so engineering teams can refer to when necessary. The most important feature tag manager directly achieved is the elimination of duplicates; this helped to eliminate lots of rework.
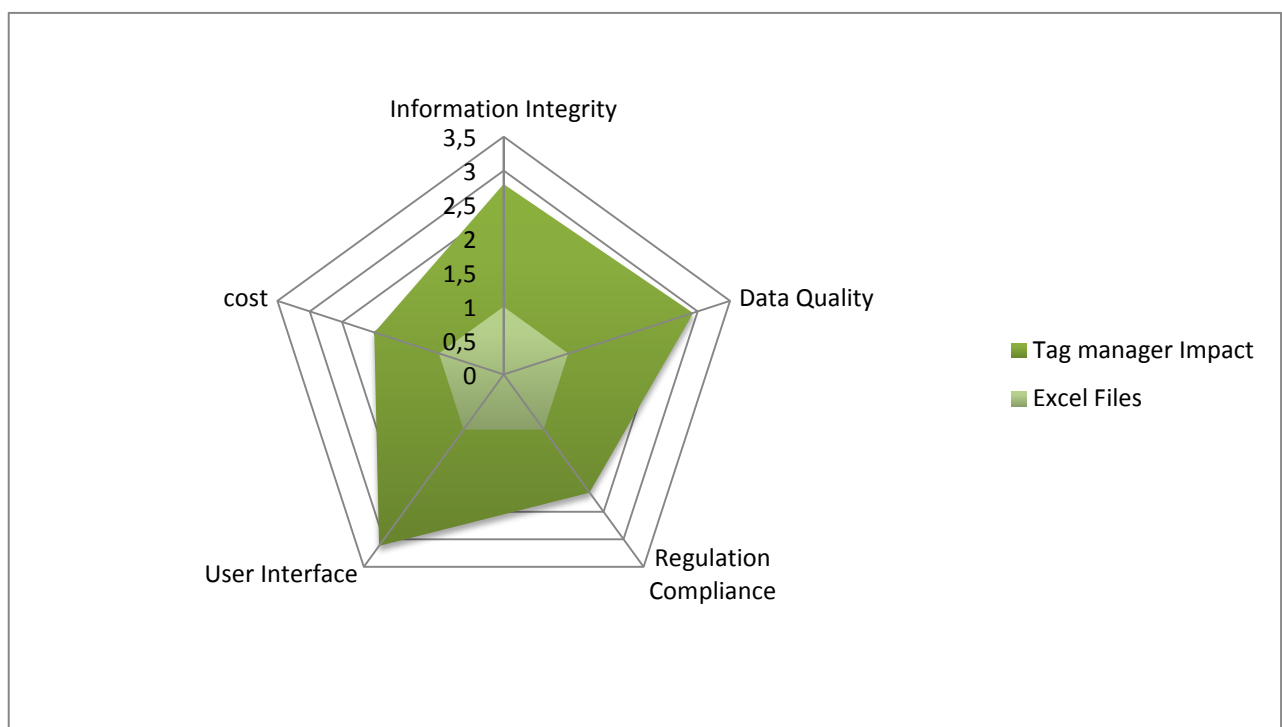

Figure 7-6: Tag manager Evaluation. Overall performance assessment

Costs achievements can be clearly appreciated if Tag manager is used in large scale modification projects with huge number of tags. The cost reduction was not the first priority to the maintenance management team at the drilling company; they basically wanted to have an IT tool that controls tag and tag-related information flow during projects they perform.

Tag manager has a positive impact on the Norwegian standardizations and regulation compliance, for the tool along with other programs and systems used have a better impact on regulation compliance if they are integrated.

The user interface has satisfactory rating grades, but many areas have the potential to be improved. Some improvements will be mentioned in the discussion chapter.

7.9   Potential Improvements to Tag manager Application

Tag manager has proved its efficiency in managing and administrating tags and tag-related information since it has been used by Drilling Company. Survey findings and results can be the basis for a second stage to perform the necessary upgrades and changes on Tag manager functionalities.

Here are some of the issues and areas where potential improvements can take place:

- Search functionalities can be improved to provide a better and more efficient access to information required during projects.

- There are possibilities to enhance Tag manager functionalities and make it more robust. Tag manager can be a more developed and integrated application.

- Tag manager minimize human work needed to find sequence numbers, some improvements can be applied on this functionality to meet Drilling Company new requirements.

- Revisions: Management of change and revisions management could be improved as well based on feedback received from users.

- TAG manager can be further developed to improved Parallel items functionality (system reliability issue)

- Importing and exporting excel files process can be improved.

- Reminder functionality can be improved so Users and projects manager can receive mails and warning messages before due date.

- Tag Categories Excel sheets exchange between suppliers and Drilling company used to transfer information between Drilling Company and suppliers could be improved.

7.10 Tag Manager Integration with Other Management Systems

Whereas Tag manager manages all tags and tag-related technical information required for projects, Drilling Company uses SAP as a tool to manage the financial and resource information for maintenance and materials management. It also uses CMMS as a database of information about its maintenance operations. The need to connect these information sources is important. Therefore, Drilling Company and Apply Sørco could work together to develop interfaces to transfer technical information from Tag manager to CMMS and SAP easily. These interfaces allow navigation from SAP and CMMS directly into Tag manager and vice versa with no restrictions.

In the long run, Drilling Company can improve features to a bi-directional interface, and that will allow Tag manager users to access SAP and CMMS data directly. For example, a SAP user who requires direct access to tags master register in Tag manager or technical information for tags or equipment identified in the SAP material master will be able to use Tag manager from SAP and find data for the required item.

Similarly, an engineer who is a Tag manager user can have access to details of the repairs and maintenance programs held in SAP and CMMS for a tag or equipment serial number.
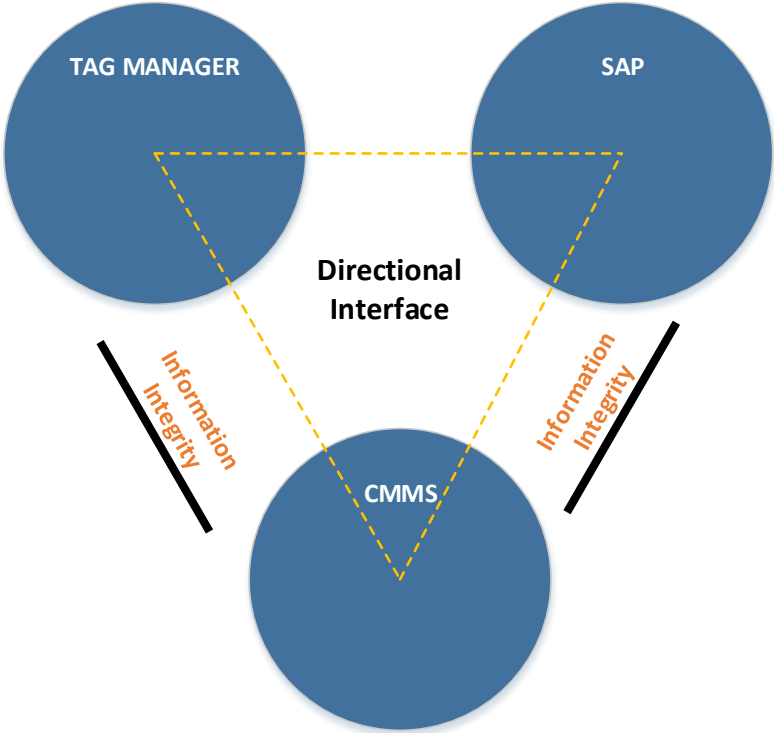

Figure 7-7: Tag Manger, CMMS and SAP Integration

Chapter 8 - Discussion and Further Issues

8.1 Introduction

The thesis discussed Life Cycle information in EPCIC and MMO projects. A review about challenges in managing life cycle information has been given to illustrate the whole image about life cycle information management before talking about Tag management in EPCIC and MMO Projects.

Tag and tag-related technical information management in EPCIC and MMO projects is an element of information life cycle management in oil and gas projects. Oil and gas companies who are involved in EPCIC and MMO projects are aware of the challenges related to Tag management and they invest good amount of money to get IT systems that can handle the huge amount of information and tag they deal with.

Large scale EPCIC projects might have tens of thousands of tags and thousands of documents that need to be managed and transferred between parties who are involved in these projects. The documents and drawing change during projects life cycle due to incomplete design or changes in designs, this has to be managed and moved to parties efficiently and on time to avoid projects overruns.

Statoil for example has worked with Intergraph to manage life cycle information of Åsgard Offshore Project. Intergraph provided a full package solution to manage all elements of life cycle information. The objective of Plant Information management data warehouse was to hold As-built data for the Åsgard Offshore Project. The success of this project made Statoil apply this solution to many other projects such as: Kristin and Snøhvit (Intergraph, 2007).

Studying Tag and tag related information management in small and large scale EPCIC and MMO projects gave me an overview about the importance of life cycle information in managing oil and gas projects. All Risk based Maintenance (RBM) activities are dependent in somehow on the information availability and quality. I can say that I have a better understanding of the supply chain and the role of contractors, suppliers and other parties in projects.

Lean thinking processes could be beneficial to life cycle information management as it can provide a solution to handle delay in projects due to data bottleneck and data quality issues. Moreover, lean processes could highlight the areas where mort of wastes in data are generated and suggest solutions to eliminate these wastes. Lean thinking application in project-based companies has a great effect on overall quality of the deliverables if applied correctly and not just as a fancy matter used to impress customers.

8.2 Challenges

One of the challenges in writing this part of the thesis was the insufficient number of studies directly addressing the topic. The available literature review concerning the focus of this study is limited and could not fully support the researcher's thesis. Therefore, this research section was exploratory in nature and mainly depended on data collection methods. A survey was carried out on tag management process to investigate the effectiveness of a software application built by Asset integrity services in Apply Sørco. This application reflects the latest technologies adopted to manage the tags in EPCIC and MMO projects. Moreover, qualitative interviews were conducted with engineers and professionals who are specialized in maintenance management and project activities where tags and tag-related technical information are used. The only paper I used as a reference which directly addressing Tag management was a paper written by Jawad Raza and R.M. Chandima Ratnayake.

8.3 Further work

Integration of tag management with other systems used by drilling company or other clients can be studied. More focus on the importance of Tag manager integration with other systems.

Benchmarking study and Best practices used in market to handle tag and tag-related technical information should be held to apply lessons learned by company and other companies. Tag manager handles one part of information life cycle and it was developed based on a request of the drilling company, the objective was to have control over the process of generating and managing tags and tag-related information mostly in small modification projects. A more integrated and developed version of Tag manager could be developed. Tag Hierarchy, Consequence Classification and Spare Parts modules can be added to tag manager to provide solutions to other clients.

Chapter 9 – Conclusion

9.1   Conclusion

Oil and gas companies do their best to avoid project overruns. The efficient planning of activities and the proper use and allocation of available resources is vital to ensure meeting project milestones and costs. Smooth flow of Information between project's parties during project's different phases is among the issues oil and gas companies fight to make it available on time and in quality needed by project's different parties.

Information and data management plays a significant role in project execution. Great efforts have been made through the last decades to enhance and improve handover of information among parties and during project's life cycle. Information and data should meet different parties' requirements and should be available on time and with high quality, thus it's important to know what kind of data is needed and when should it be available to avoid tasks bottlenecks.

IT solutions providers such as AVEVA and Intergraph have been so active in providing oil and gas companies with IT solutions needed to manage life cycle information; the point here is that these IT services provider should provide IT solutions that reflect the project management logic, IT solutions should be aligned with project's models used by companies.

Asset Integrity Department at Apply Sørco developed and Implemented Tag manager, IT system to handle Tag and tag-related technical information in maintenance and new construction/modification projects for the Drilling Company. Company's staff used to do all tag's activities manually and they wanted to improve this process and automate it. Tag manager succeeded in eliminating many obstacles users experienced during managing tags and tag-related technical information. Continues improvement based on functional needs and feedback from Drilling Company is important to raise the capabilities and features of asset manager.

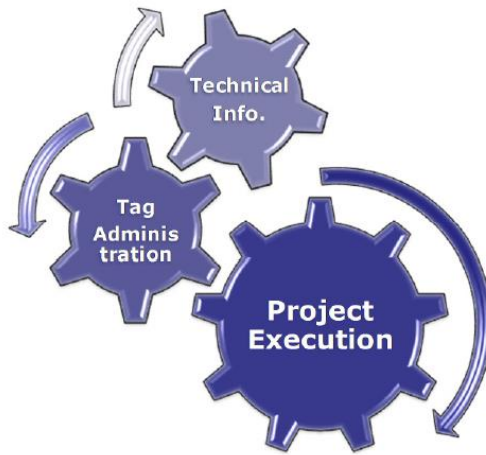Figure 9-1: Project execution in M&M and EPCIC projects. Source (Raza and Ratnayake, 2012)

Based on the survey results, it was clear that Tag manager has benefited Drilling Company in many areas. Improvements on tag's and tag-related technical information quality and availability have been achieved. Implementing Tag manager has benefited the company to align with information and data sharing regulations as well.

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APPENDIX A

TAG Management Process/Software Application Questionnaire

This questionnaire is a part of a master thesis in partial fulfilment of the requirements for the degree of master of offshore technology – Industrial Asset management at university of Stavanger (UiS).

Tag management process in EPCIC and MMO projects will be the case study of this master thesis. One of the objectives of this case study is looking for improvement opportunities in tag management process and the application software.

The questions are divided into different categories which reflect the master thesis objectives. The questionnaire approaches four major areas: Functionality, usability, savings/quality and process. The answers will used for further quantitative analysis. The answers should be given on a scale of 0 to 5 as indicated in the table below.

Answer	Explanation
0	Do not know
1	Strongly Disagree
2	Disagree
3	Neither Agree nor Disagree
4	Agree
5	Strongly Agree

It is worth mentioning that that information, data and names used in this master thesis will be confidential and nothing will be presented publicly. The master thesis is a collaborative work between Apply Sørco AS and UiS.

Thank you for your time and your valued input.

Apply Sørco AS   University of Stavanger   Menyar Diab

TAG Management Evaluation Questionnaire

Considerations

	TAG manager Evaluation and Assessment	0-5	Comments (Suggestions and other notices)
1	**General Questions**		
1.1	How many active users use TAG manager today? How many users have received a learning/training course?		Not relevant to the current scale
1.2	Requirements and special needs of Tag manager were identified by the drilling company staff?		
1.3	Work process of Tag manager was effectively understood before and during building TAG manager.		
1.4	Tag manager users (LCC, DC, project engineers, Onshore/Offshore engineers) were included in the development of TAG manager.		
2	**TAG Manager Customization**		
2.1	All the activities needed to customize TAG manager for Drilling Company specific use were performed effectively and included: • Efficient import of project data • Establishment of tag master register		
3	**Information Integrity**		
3.1	TAG manager assists Drilling Company to strengthen its Asset/Project data and information integrity		
3.2	TAG manager assists Drilling Company to increase and enhance the availability of data and other technical information which is needed during EPCIC and MMO projects.		
3.3	TAG manager provides a reliable database of Tags and tags related information.		

3.4	TAG manager helps users to better understand the flow of information and tags status changes during Project Execution Model.		
3.5	TAG manager enhances communication between all parties who are involved in projects.		
3.6	TAG manager implementation resulted in a better teamwork and a smooth flow of data and information among different parties involved in projects.		
3.7	TAG manager has a positive effect on meeting the deliverables and reaching projects milestones.		
3.8	TAG manager provides a reliable and efficient database for consequence classification, maintenance planning and preventive maintenance activities, and spare parts evaluation, in compliance with Z008.		
3.9	TAG manager minimizes human errors related to TAG generating by making TAG manager the only source of Tags. It also eliminated doubled tags and helped to minimize work stress by removing stress factor of doing same things again and again.		
3.10	Different Tag statuses as defined in Tag manager are clearly communicated internally (by TAG manager users) and correctly linked to Project's phases during PEM		
3.11	TAG manager has the ability to handle old tags which were not generated according to Tags regulations, this included changing tags and keeping relevant data in TAG manager database.		
3.12	Using TAG manager assists Drilling Company to meet mechanical completion requirements on time.		
3.13	TAG manager facilitates the handover of assets information from project team to the operations phase through early planning of tags and tag related referenced information.		
3.14	TAG manager provides a potential for adding value by sharing information which resulted in enabling parties to contribute to an existing base of information.		
3.15	How important do you think the integration of TAG manager with Drilling Company ONIX SAP and ProArc is? Do you think it's essential? Have you experienced any challenges or obstacles regarding this integration process?		
4	**Quality achievements/Cost Savings**		

4.1	TAG manager assists Drilling Company to improve projects overall quality through providing a reliable and up to date tags and tags related referenced information.		
4.2	TAG manager reduced the amount of manual work / Man-hours required to correct and follow tags as all of tags are generated by TAG manager which minimizes amount of human error in MMO and EPCIC projects.		
4.3	How Efficient is TAG manger in keeping its database clean from unused and obsolete tags.		
4.4	TAG manager assists in reducing costs by automating most of tags generation activities which implies that less man hours are used in this process. In your opinion. The total amount of man hours used to generate and administrate tags were reduced after using TAG manager by: • 0% - 25% • 25% - 50% • 50% - 75% • More than 75%		
5	**Norwegian legislation and Regulations**		
5.1	1. How efficient has TAG manager been in helping your company ensuring that the necessary information is acquired, processed and communicated to relevant users at the right time. 2. How efficient has TAG manager been in working as a tool to keep all information with As-built tags, and to coordinate and assure quality of tags related information before using them in company maintenance management system. 3. How efficient has TAG manager been in helping Drilling Company to provide a technical information database for all parties during offshore installation's life cycle. 4. How efficient has TAG manager been in ensuring that all data has one source and responsible owner. 5. How efficient has TAG manager been in working as a tool which enables using concurrent engineering in projects life cycle phases		
6	**User interface**		

6.1	How efficient is TAG manager in enabling users to accomplish tasks more quickly! How efficient is the system speed!		
6.2	It was easy to learn how to operate TAG manager and understand its different functions.		
6.3	Are TAG manager's functions defined and easy to understand?		
6.4	It's easy to find help and support from IT when users face any problems using TAG manager		
6.5	How often do users experience bugs? When any bug or error occur, rework is required?		
6.6	The process of export and import of tag categories excel files is fast and reliable.		
6.7	It's easy to work with excel worksheets generated by TAG manager. Excel files Information is clear and complete and it's easy to extract required information from these worksheets.		
6.8	The information appeared in the screens is related to my work such that there is no unnecessary information that makes me disturbed.		
6.9	The software is consistent e.g., same action sequence, colours, and layouts.		
6.10	It is easy to undo mistaken actions		
6.11	The user interface is organized in purposeful /logically way.		
6.12	How often do users experience crash / freeze (is the system stable and reliable!!)		