EFFECTIVENESS OF FACILITY MANAGEMENT IN PETROLEUM INDUSTRY

by

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Dissertation submitted in partial fulfilment of the requirements for the
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CERTIFICATION OF APPOVAL

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A project dissertation submitted to the

Petroleum Engineering Programme

Universiti Teknologi PETRONAS

In partial fulfilment of the requirement for the

BACHELOR OF ENGINEERING (Hons)

(PETROLEUM ENGINEERING)

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CERTIFICATION OF ORIGINALITY

I hereby verify that this report was written by me, Raja Mohammad Haneff Bin Raja Haron (14578). I am responsible for the work I have been submitted in this project, the work have that had been done is my own except as specified in the references and acknowledgements.

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ABSTRACT

Most of the oil platform piping system in Malaysia using carbon steel as the material. This selection of material, giving a remarkable impact as the chosen material is susceptible to certain conditions such as when the piping system dealt with high corrosive content such as hydrogen sulphide, H_2S and the environment of the platform made the material is susceptible of multiple types of corrosions. Even though, insulation management can prolong the life span of the pipe, it is better if consideration of material selection taken into account for higher optimization. Main purpose for this research is about the critical factors that affecting the efficiency of the two selected major components which are material selection and insulation management of the piping system. This effectiveness of the major components shall reflect the scope facility management at topside facilities pipeline especially. With thorough questionnaire preparation of Likert Scale, all the data acquired will be analyses by The Average Index Formula for rating the factors provided. As for the result of this research, it is expected that the problem of pipeline facilities will be identified and discussed. This research also tend to be used as a recommendation for the possible application of the critical factors studied and effectively implement to control and minimized the undesired event. These possible critical factors can also happen in Malaysian oil and gas industry will be provided and used as consideration in their business guideline.

ACKNOWLEDGEMENT

In completion of this Final Year Project entitled Effectiveness of Facility Management in Petroleum Industry, I would like to take this opportunity to express my deepest appreciations to all the parties that have made this project successful. First and foremost, my greatest gratitude goes to Ir. Idris Othman, my supervisor, for his guidance and assistance throughout the year. Under his supervision, I have gained valuable experience and new knowledge. Secondly, I would also like to express my gratitude to the Petroleum Engineering Department, Universiti Teknologi PETRONAS (UTP) which is led by Assoc. Dr. Ismail Bin Mohd Saaid (Head of Petroleum Engineering Department) for providing me the facilities and equipment used in this research. I would like to thank Mr. Afiq from Oceaneering Services Malaysia of Asset Integrity Department for his assistance. Last but not least, I would like to thank my family, lectures, staff and my colleagues who have been supporting and helpful to me throughout this final year project.

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CHAPTER I

INTRODUCTION

1.1 Project Background

Petroleum related industry is a complex industry and facility management is one of very important aspect that should be looked into. This industry subjected to many uncertainties and affected by financial, government law, political, construction, operation and maintenance. This facility management covers all aspect from exploration of possible location of the reservoir up until decommissioning. Facility management include both upstream and downstream that need to be adequately highlighted so to ensure its efficiency.

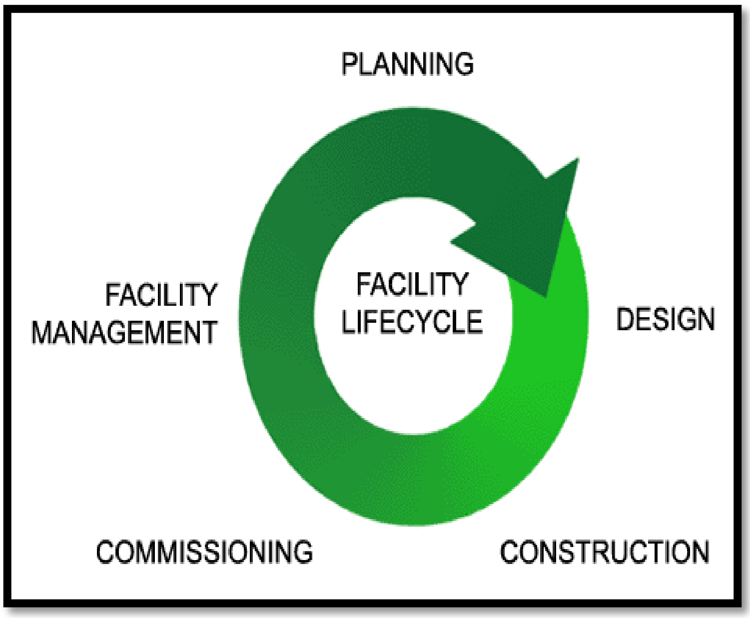


Figure 1: Facility Management Scope

However to build this management to the outmost effectiveness could be very difficult, but with right way of doing it is the key to success. To meet increasing demand, global petroleum companies strive to seek technologically innovative and optimize the cost for oil production while maintaining the importance of safety and environmental concerns. A structured and systemic approach will enable us to build facility management plan effectively.

In this study, the area which will be investigated is facility management at topside facilities pipeline. Several differences can be point out for the effective and non-effective facility management at pipeline facilities. There are optimizations of cost, implementation of good design parameters, longer life cycle of the pipe, low accident rate. These key parameters will be investigated thoroughly to achieve the effectiveness of this facility management. Critical parameters will be selected and discussed into further details to help in any angle of possible improvement.

This research will be conducted from Oceaneering Services Malaysia which specialised in asset integrity management. Usage of proven concept imbedded in software called SOLV, an integrated system for asset life-cycle corrosion and insulation management, parameters mentioned earlier will be investigated in term of material selection, insulation and risk-based inspection (Rigzone.com, 2013).Services provided by this company are in use on 72+ offshore facilities and offshore plants globally for Statoil, ExxonMobil (Norway), Petro Canada, Teekay, Talisman, Enbridge(US), Petrobras and ConocoPhilips-UK (Azhar abdul Aziz, 2010). The focus will be at its pipeline asset at topside production facilities. With the thorough approach used the effectiveness of the facility management implemented shall be studied.

1.2 Company Background

Figure 2: Oceaneering Logo

Background

Oceaneering was founded in 1964, has grown from many sector of business in The Gulf of Mexico to a diversified, advanced applied technology organization operating around the world. Oceaneering achieved this growth driven by high intellectual plan of both internal and research and development augmented by strategic acquisitions.

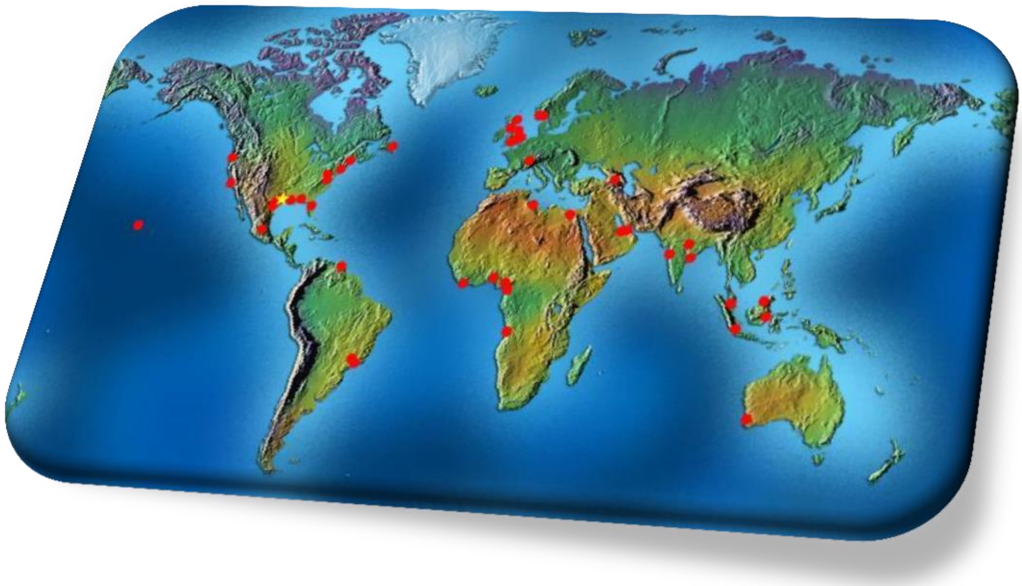


Figure 3: Global Company Locations. Oceaneering located in 68 location involving 23 countries

Core business

There are many part of asset integrity covered globally. They are:

- Technical integrity management
- In service inspection
- Pipeline integrity
- Crane and lifting certification
- Corrosion management
- Advisory services
- Maintenance and integrity engineering
- Risk and HSE consulting

Some of this part is covered in Oceaneering Malaysia. They are technical integrity management, maintenance & integrity engineering and corrosion management.

Corrosion management

Asset integrity provides a specific technology called SOLV that take corrosion management to a higher standard. SOLV is a unique and effective method including a knowledge database. It gives more superior planning for inspection and fabric maintenance, including corrosion under insulation. The objective is to achieve optimal integrity with the experience and best practice from the North-Sea.

Technical integrity management

Can be defined as a comprehensive program designed to assist facilities in managing their operations safely. The recognized industry standard applies to all stages of the design and CVP. It is a “cradle-to-grave” program that encompasses the full life cycle of a facility. It is based on the clear identification of the potential hazards associated with such facilities and the risk management program developed to control the hazards.

Maintenance & integrity engineering

Maintenance engineering services are specifically designed to meet the demands of the customers aiming to improve operational performance and profitability. Oceaneering’s methodology in development of a risk based maintenance and inspection program is based on: relevant authority’s rules, codes and standards, conditions of class, in addition to industry best practices.

1.3 Problem Statement

1.3.1 Problem Identification

Variations of highly important oil and gas project have resulting an increment of critical sense in term of management. This is based from a huge investment in this sector and also functioning in long time period with high risk operation together with the global economy and corporate revenue decreasing condition, stakeholders are calling for enhanced risk management, Return on Investment (ROI) and more considerable transparency (Ernst & Young, 2011).

There should be an optimize way on how to spend millions of dollars in oil and gas investment. In the history of oil and gas industries, there were several unexpected tragedy happened which result in loss huge loss. In late April 2010, a tragic accident known as the Deepwater Horizon Explosion in the Gulf of Mexico snatched away 11 lives and resulted about 5m barrels of oil discharged into the ocean. Following the massive oil discharge, marine live hundreds of miles from the coastline are threatened. Based on the United States government’s estimation, the Deepwater Horizon disaster was confirmed as the largest accidents ever involving the release of oil into the ocean. The blame was taken by a complex linked series of human decision, engineering failure, mechanical designs and some operational applications (Who's blamed by BP for the Deepwatr Horizon oil spill?, 2010). This is mostly because of the implementation of good facility management never took in place.

In Malaysia, most of the oil platform piping system using carbon steel as the material. This selection of material, giving a remarkable impact as the chosen material is susceptible to certain conditions. This selection of material is not efficient when the piping system dealt with high corrosive content such as hydrogen sulphide, H_2S, the environment of the platform such as offshore platform which made the material is susceptible of multiple types of corrosions.

This is where we talk about the efficiency of the facility management. Even though this field of management is huge, this paper will focus on asset integrity of the pipeline. This includes the section of material selection, insulation management and risk based inspection.

1.3.2 Project Significance

Effectiveness of the facility management at topside facility pipeline can be reflected by many factors. There are reduction in the overall cost for the piping system, increment of life cycle of the pipe, quality improvement of the pipeline condition and ensure the safety and health of the operating personnel.

Better facilities management will also improve quality of the condition of pipeline. This would be achieved by implementing the asset integrity management to the pipeline such as insulation or coating. Right way of doing both coating and insulation will help to prolong the life cycle of the pipeline and even increased into better condition. With longer life cycle of the pipeline, the cost of replacing or abandoning it will come to halt.

Ensure the health and safety of the people operating the facility. Usually this factor taken for granted. There were some incidents of gas leaking through pipeline happening that take the lives of the operator. It was the job of facility management to remind their worker into practicing better ways in handling such situation. With better planning and understanding of the facility management, it is hoped that such incident will never took in place.

For the result of this research, it is expected that the problems regarding to the facility management effectiveness in general is identified and discussed. The possible factors are also provided for general oil companies especially in Malaysia to take into consideration of the factors as the guideline in their business and made an impact to improve business performance with the goal to realize its vision and resulting in positively contribute to Malaysia's economy.

1.4 Objective

This research is mainly focused on two (2) objectives, as follow:

1. To determine the foremost factors concerning effectiveness of facility management at topside facility pipeline in oil and gas industry.
2. To recommend possible application of the factor studied and effectively implement it to ultimately minimised or control the undesired event.

1.5 Scope of Study

This study mainly focuses on the effectiveness of facility management. The area to be investigated is at topside facilities pipeline on the platform itself. This paper will determine the critical factors that help to increase the effectiveness of facility pipeline on the selected platform. These factors will be based on the material selection of the pipeline, insulation requirement of the pipeline and from risk based inspection data of the platform. This investigation will cover the pipeline system before selection of the material in early phase up until one life cycle of the system. Further investigation on how to increase the efficiency of the facility management of the pipeline system will be conducted. All possible criteria will be brainstormed individually, research from the available research paper and asked from the engineer in Oceaneering Services Malaysia Company.

All the possible factors applicable will be strategized to effectively minimize the cost of pipeline system, increase the quality of the pipeline condition, longer the lifecycle and last but not least, ensure the health and safety of the operating personnel in charge.Along with the research content, there are including the efficiency factors identification with Likert Scales of respective factor that effect effectiveness of pipeline facilities and rank by distributing questionnaires to some respondents working on Oceaneering's. The questionnaires are prepared to collect data from about 20 voluntary respondents who are randomly selected to supply information for this study. The target population is the one who are responsible for static equipment on the platform, the one who manage the insulation programme for the pipeline and the one who investigate the risk based inspection on the pipeline.

Accordance with the objectives, the literature, and availability of the worker's in Oceaneering and the research hypotheses, only one type of questions are developed in the questionnaire. They are multiple choice questions which were distributed to mostly engineers. Beside that, interviews session were conducted for further analysis.

As the area of study is specified to only pipeline facility management, the scope is not a burden for the author to be completed. The time frame given to conduct this research is also achievable as the preliminary data already in possession. Additional data can also be requested from the author's supervisors at the company.

CHAPTER II

LITERATURE REVIEW

2.1 Facility Management Overview

In last few decades, definitions for facilities management have been broaden to various understanding. It was grouped into how it operates and into degree of it offers sustainable chances for mainly business (Tay & Ooi, 2001). IFMA (2013), define facility management as fields of careers that imbedding multiple disciplines to guaranty purpose of built environment by integrating all possible factors. It was conventionally expected as poor relation of real estate and construction discipline where buildings were maintained, services and cleaning (Brian & Brooks, 2009).

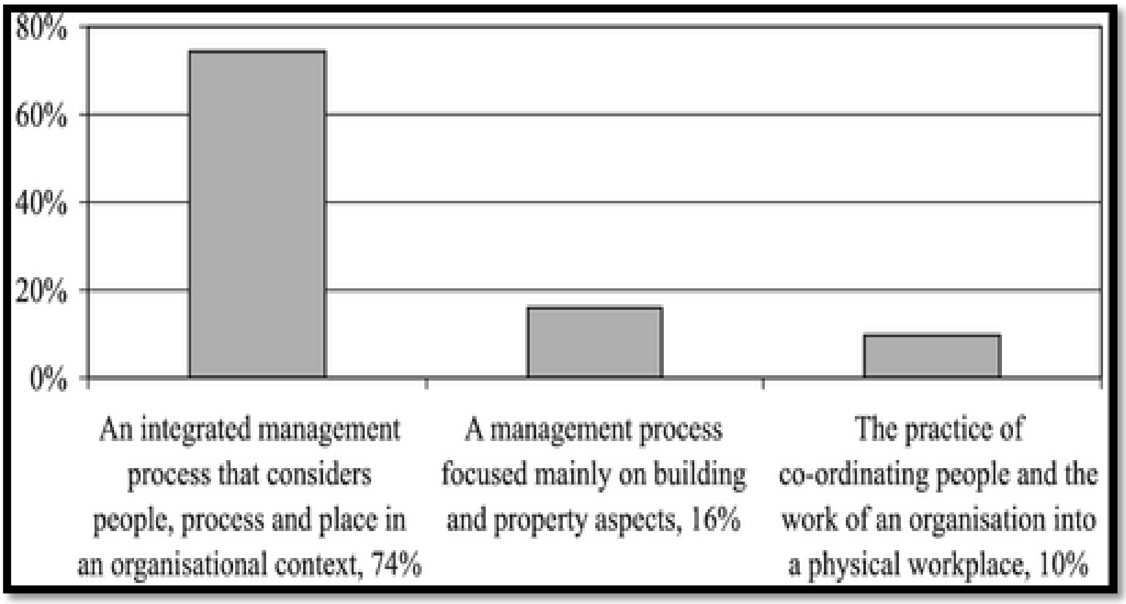


Figure 4: Industry Definition of Facilities Management

Involvement in facilities management will make you realize that this field is quickly adapting to advancement of new era and gradually become challenging. The significant of this department was to optimize the budget, increasing the efficiency and maintain the integrity of the facilities. In other word, this management is about achieving the cost reduction not as usually expected as method to increase the business competitiveness (Nazali & Micheal, 2009). Kaya et al. (2004) idea is that facilities should be planned with best way that support to business needs and along the way result in achieving the proposed objectives. This is where the module of services within the scope of facility management need revised in depth to enable it to create the best values to the business world (Goyal & Pitt, 2007).

In South East Asia, there was survey conducted for facility management maturity. The questionnaires generated with mission to acquire some insight of facilities management level, demand and opportunities. This is including some general questions about business conducted ant its operational market with period of involvement of particular facility management field. The results of this survey indicate that a facility management was differs in progress in South East Asia. This is particularly seen throughout Hong Kong and Singapore but only in certain area of Malaysia. The reason was lack of exposure but progressing gradually to develop (Mike & Edward, 2004).

2.2 Facility Management in Asset Integrity

According to the incidents happen in Petroleum industry it is important to have the efficient control of the risks in any operations. Most of the company worldwide already taking the initiatives to improve their Asset Integrity Management that basically cover all part of production activities. This means that the Asset Integrity Management covers all part of facility progress by its physical condition with imbedding other element such as processes, peoples and activities to prevent any possibility of risk. As example, principle used in Total E&P Producing Affiliates (PAs) shall take into account of 3P principle, namely: Plant, Process and People. They ensure the management of asset integrity report all regarding matters directly to person in charge (Rocher, Perrollet, & Muir, 2011).

Complex issue in process industry is what asset integrity was made of. Activities such as designing, installation, maintenance and decommissioning will influence the integrity of the infrastructure and equipment at different stages of the life cycle. Nowadays, asset integrity significantly maintains and improves the facility. This requires shortening the process to the upper part of the dotted line as shown in Figure 3. The activities in upper part can be divided into operational integrity and mechanical integrity. Operation beside inspection, maintenance and modification are mechanical integrity (Jakiul & Faizal, 2012).

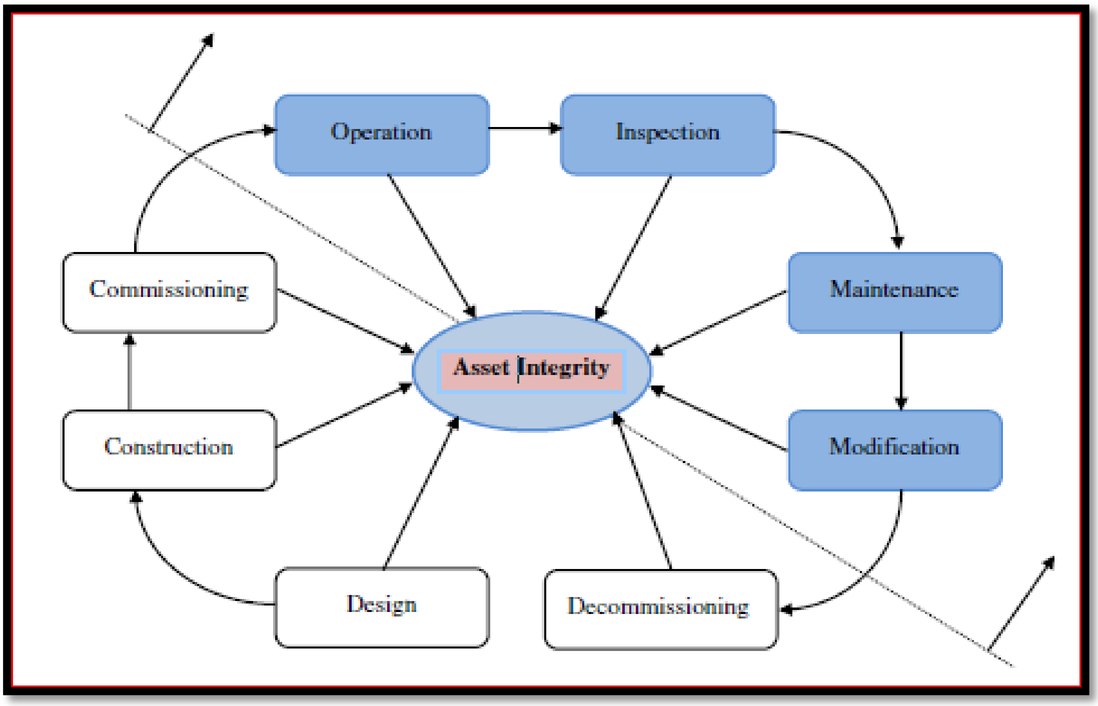


Figure 5: Elements Influence The Integrity of an Asset Over its Life Cycle

Asset integrity management cover all facilities not only oil facilities but as well as pipeline, structure and all units available. Minimizing the risks by minimizing its consequence is what we can expect from this Integrity management. It is to ensure the well-being of the asset for its purpose to be running safely and hence improving production performance. This Integrity Management was given the purpose to serve in improving the integrity of the facilities and pipeline until it is to be expected "Our asset is safe, we know it and we can demonstrate it" (Dave & Roland, 2009).

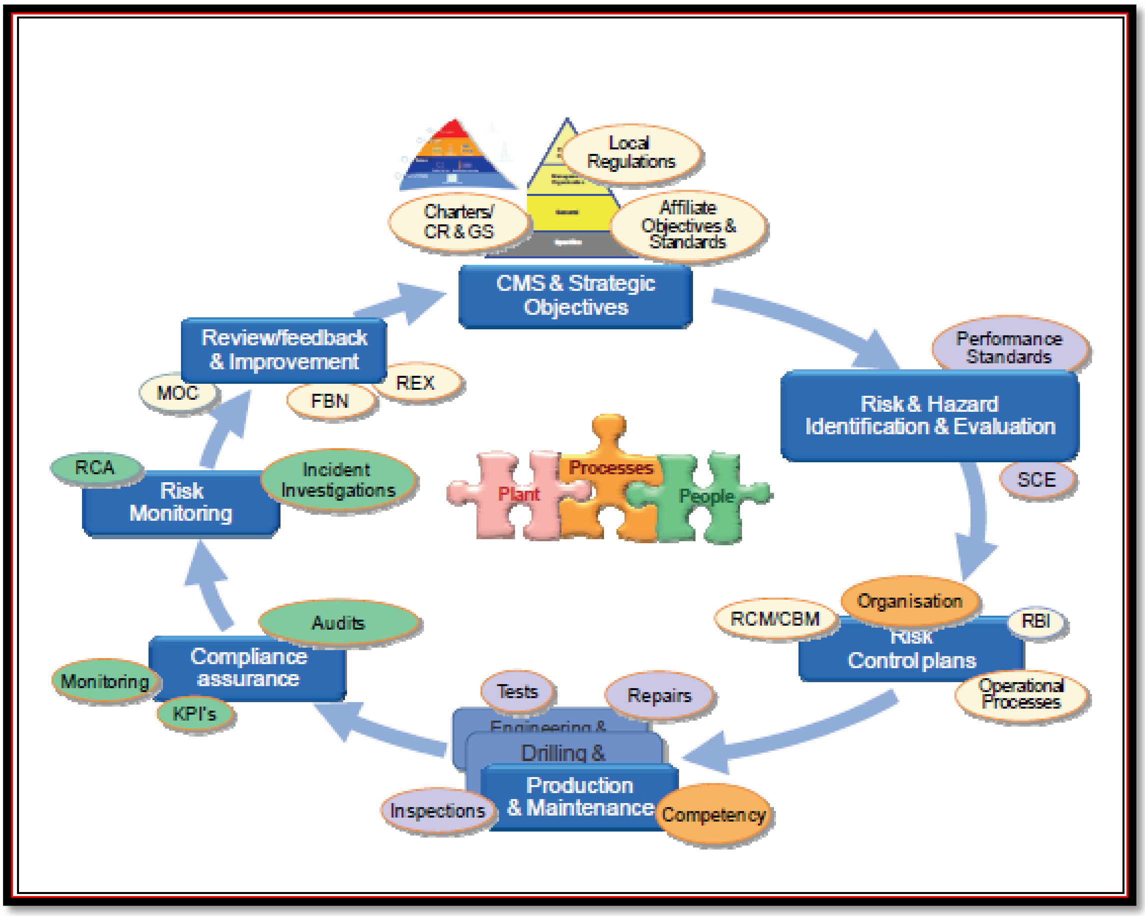


Figure 6: The Integrity Cycle

Figure 4 shows the diagram that illustrates all main processes that occurring throughout the whole life cycle of asset. All of them will contribute in increment of its integrity. Particular attention to below steps should be brought into our attention for us to keep up current industry practise (Rocher, Perrollet, & Muir, 2011):

1. Development of Asset Integrity policy and strategies of dedicated Producing Affiliates (PA) standards and Company Management Syatem.
2. All possible major risks were identified in all operations by detailed risks assessment.
3. All the risks must be controlled by inspection, testing and maintenance.
4. Sets of indicator such as key performance indicator to be implemented to measure asset integrity with conformation of expectations.
5. Process Safety, Inspection, HSE and Asset Integrity must be defined by audits.
6. All reminder of lesson learnt from incidents should be in place and available to all.

This Facility Management success in Integrity Management heavily related to establishment and maintenance of effective technical and business communication in all area of an organization. Full persuasiveness on operations, engineering function and top management handling must fully taken into account in all Integrity Management process (J., John F., J. Kirk, John C., & Kenneth, 2010).

2.3 Facility Management on Pipeline Integrity

Complex activity is what we can tell about management of Asset Integrity in petroleum industry. All the process that handled by equipment in oil production facility were exposed from damage mechanisms. Its occurrence is governed by present of contaminants in processes facility (Saleh, Vinayak, Hari, N. Harinadha, & Reji P., 2013).

Statutory requirements are the cause for pipeline integrity management in North Sea. Their government expecting that all usage of oil carrying pipelines undergoes an inspection. This usually happen as one of ways to ensure pipeline credibility from any environmental catastrophe. By this regulation the government required people for handling inspection to regularly inspect pipeline for any possible evidence for malfunction or degradation. As per requested by this regulation, oil company specifically ensure operators for various kind of inspections by criticality basis and produce report to be submitted as it will be held as engineering data that can predict the trend of abnormalities. This data not only used for forecast but also as basis information when remedial work might be required. As advancement with time, oil and gas industry have evolve the methodologies for managing data through risk based analysis. The result will be used to ensure integrity of the pipeline or work over procedure (Strutt, Baker, & Atkins, 2010).

2.3.1 Material Selection

There are different types of steel used as the pipeline. It means that this pipeline is differs from one another. In bigger view of types of pipeline, there are stainless steel, carbon steel and titanium pipeline. However, each one type of this material divided into various kinds. For an example of stainless steel there is austenitic stainless steel, ferritic stainless steel, duplex stainless steel, martensitic stainless steel and precipitation hardening stainless steel. All of them have different physical and metallurgical characteristics (Amanda, 2006).

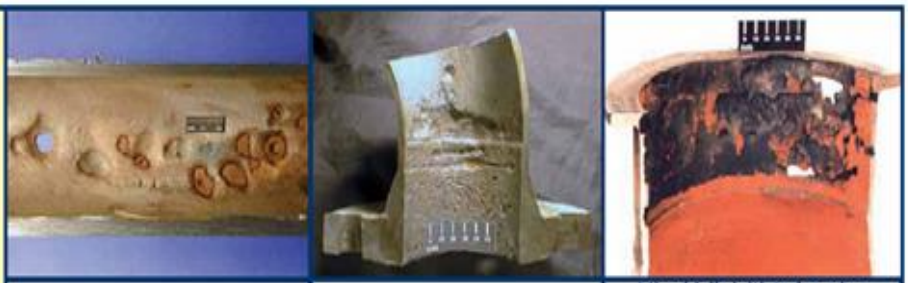
In order to perform material selection, the data about the condition of usage, type of fluid handled and any factor that lead to malfunction of the material. For an example, stainless steel cannot be used for piping in seawater system. This material of pipeline is susceptible for seawater system purpose because it leads to Microbial Induced Corrosion by microbial microorganism in seawater such as sulphate reducing bacteria. This corrosion will introduce fouling and lead to degradation mechanisms that result in pitting and crevice. The factors for fouling to occur are (Cescor, 2010):

- Presence of water
- Presence of sulphate reducing bacteria
- Presence of sulphates (SO_4^- above 10ppm)
- Anaerobic conditions (even only local)
- pH between 4-10
- Temperature below 70-80 ^oC.
- Salinity lower than 140 g/l

Below is the summary of Microbial Induces Corrosion (Corrosion Threat Handbook, 2008):

THREAT #4 – MICROBIALLY INFLUENCED CORROSION (MIC) AND DEADLEG CORROSION				
CAUSES	OCCURRENCE	SUSCEPTIBLE SYSTEMS	INSPECTION / MONITORING METHODS	MANAGEMENT
– Primarily sulphate reducing bacteria – Stagnant (deoxygenated) environments	– Water containing organic nutrient and sulphate – Deadlegs – permanent or operational – Mothballed plant – Under deposits	– Water injection – Produced water treatment and re-injection – Firewater – Drains – Seawater – Occasionally in – hydrocarbon processing systems, e.g. vessel trim, recovered oil lines	– Microbial and sulphide sampling and trending – UT – Radiography – Biostuds / sidestream monitoring	– Biocide – Circulation – Deadleg register – Remove dead legs if possible – Drain deadlegs frequently – Risk based inspection – See EI Guidance document Appdx B, Section 4

DEGRADATION MORPHOLOGY



MIC pits in carbon steel | MIC in a carbon steel deadleg | Microbially initiated erosion corrosion of Cunifer (90/10 copper-nickel)

Figure 7: Summary of Microbial Induces Corrosion and Dead Leg Corrosion

2.3.2 Pipeline Insulation

Wikipedia states that pipe insulation as a thermal or acoustic insulation used at the surface of pipe work. Coating is also type of insulation on the surface of pipeline. Many reason for insulating pipeline and most importantly about the cost. Basically pipeline is susceptible for various conditions. For example, there are conditions that favour corrosion. By this insulation those corrosion can be prevented and the life cycle of the pipeline will be prolong. As for heat conservation material used to insulate the pipeline should be appropriate.

There are several insulation class defined (Piping and equipment insulation, 2006):

Heat conservation

Its purpose is for reducing the heat loss or transfer and to maintain temperature for efficient operation in the process.

Cold medium conservation

Its purpose for maintaining the low temperature and control heat input to the process.

Personnel protection

It is prevention of contact from skin. The temperature for this class is below -10^{o}C or above 70^{o}C. Such places is confined to a distance of 2.1m vertically and 0.8m horizontally away from walkway. Insulation will be required the usage of guards for pipe with temperature above 150^{o}C.

Frost protection

Its purpose is to prevent frosting, solidification and condensation. Have two types: insulation with heat tracing or without heat tracing.

Fire protection

Its purpose to reduce heat input and secures the temperature below the specified critical temperature when exposed to fire scenario. If no fie scenario or critical temperature specified, the protection is usually for temperature up to 400^{o}C for 30 minutes.

Acoustic insulation

Its purpose for regulate noise emissions until it meets the area noise requirement for working conditions.

External condensation and icing protection

Its purpose is to prevent outside condensation with operating temperature below 20^{o}C.

Illustrations of insulation for class 1, Heat Conservation (Daniel, 2012).

Figure 8: General View of Heat Conservation Insulation of Piping

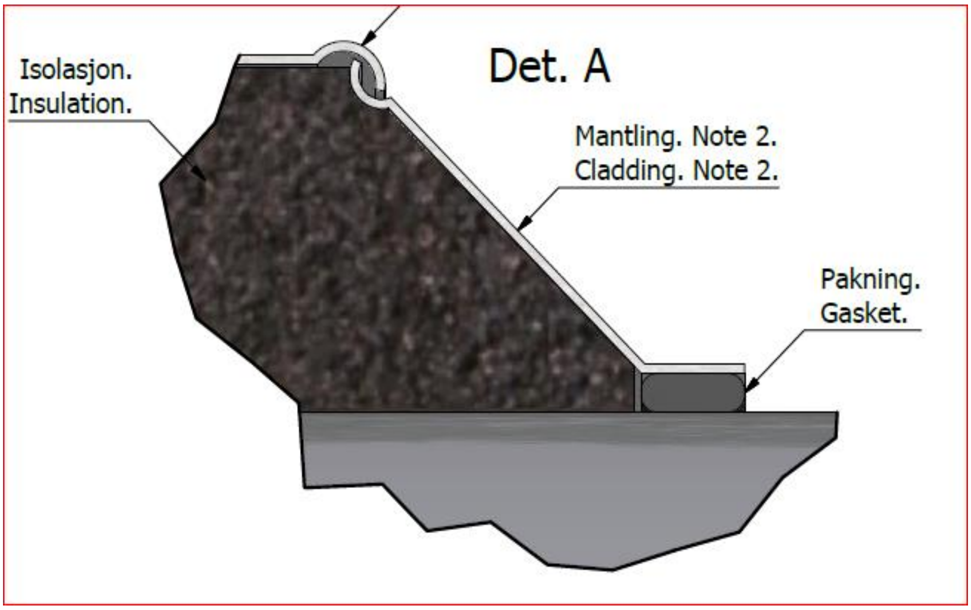


Figure 9: Focussed View of Heat Conservation Insulation of Piping

The cladding is arranged as in Figure 7 to prevent the any condensate or rainwater from sweeping through the insulation. The placement of gasket is to prevent any possible part from leakage.

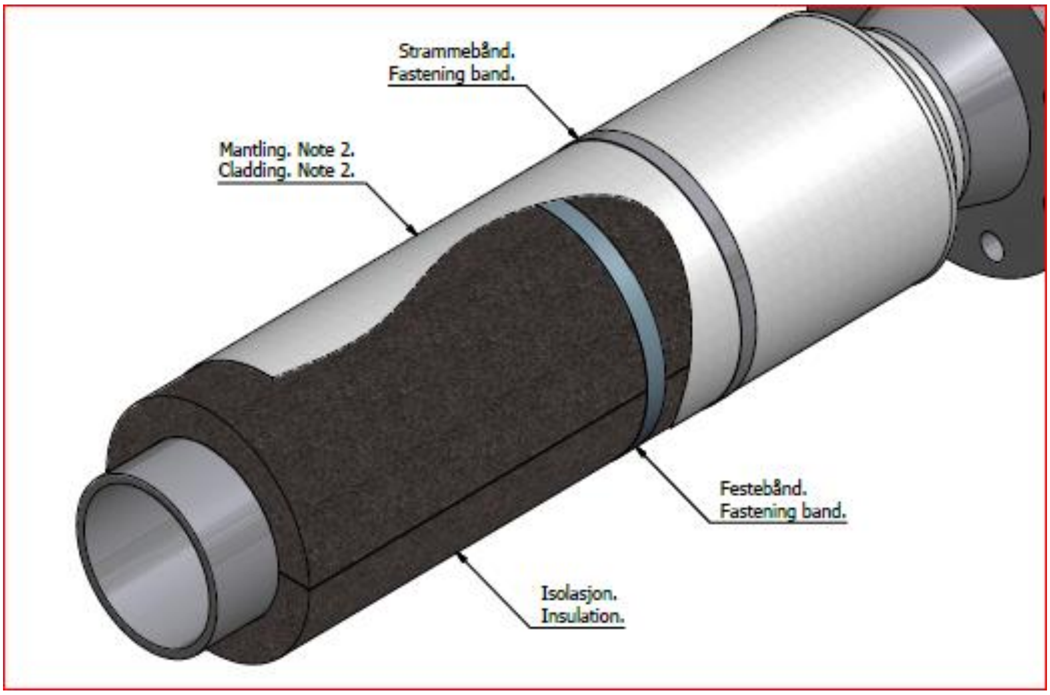


Figure 10: Arranged View for Heat Conservation Insulation

There are two fastening band available. Both of them are to maintain the location of the insulation and metal cladding.

CHAPTER III

METHODOLOGY

3.1 Project Activities

There are several activities comprising six (6) main activities in performing this project, they are as follow:

1. Background study: to analyse the Facility Management in deeper sector
2. Questionnaire preparation
3. Collection of the data
4. Data acquired from the form will be analysed
5. Recommendation will be pointed out based on the finding
6. Final report writing

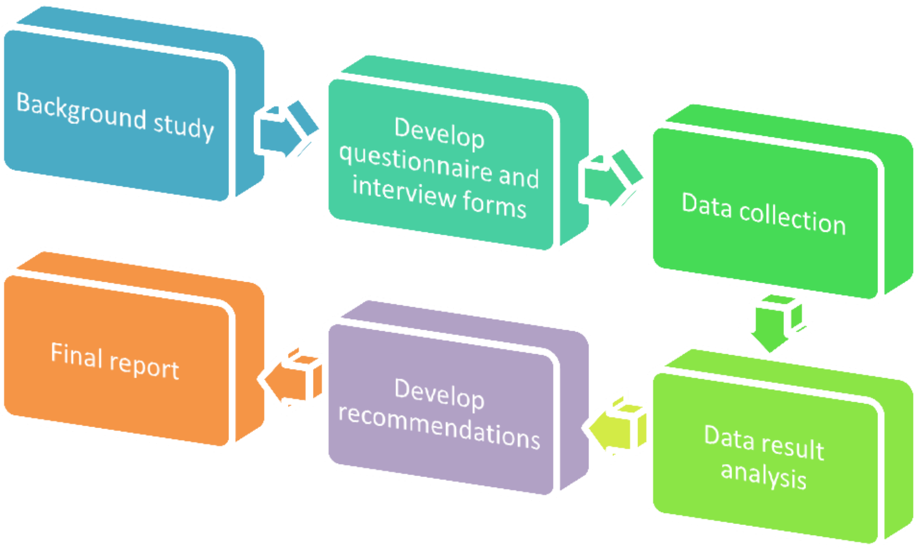


Figure 11: Methodology

3.2 Tool Required

Basic tool needed into performing this research study are from questionnaire form, survey and interview from the person who faced the real task activities.

3.3 Data Collection

The data used for this research study will be divided into two parts; they are primary and secondary data. For primary data will be acquired from questionnaires prepared and interviews conducted while secondary data will be collected from resources such as books, journal, previous thesis and research paper. However the primary data only can be generated through pilot-study process. Pilot study is a small scale study that used to derive the complete scale of the study. It is also known as feasibility study as well as specific pre-testing of a particular research instrument. In this research, pilot-study used to generate adequate questionnaires question for the critical factor that affecting the effectiveness of material selection and insulation management. Small group of engineers in Oceaneering will be involved in this preliminary research. Improvement of questionnaires can be done after this process conducted.

Table 1: Effectiveness of material selection and insulation management

People	• Engineer's job scope • Supervisors needed to check quality of contractors work • Technician should handle every situation efficiently • Operating personnel should operate all asset within safe range operation • Manager should be money wise and make investment justificication • Using in-house personnel on core asset activities • All the personnel should have competence training

	completed
Process (property)	• Maintenance services • Technology used • Its design and reability proven • Good relationship with material provider. • Bonus given for reduction in execution time while all requirements fulfilled • Assurance of quality and and integrity of the asset • Operating facilities in safe manner • Assessing and verifying in place perfomance
Environment	• Should be dealt using appropriate practise standard • Identifying the environment of the platform such as in harsh water environment or calm water • Field data collection and management • Maintenance by implementing risk- based inspection method • Using guideline provided for practise and operating procedure • Safe- work practise • Environmental information • No language barrier should present

3.3.1 Primary Data

Obtained from extant literatures, a list of efficiency factors for facility management of pipeline was prepared and given to the 25 respondents. There are two (2) sections in the questionnaire, as follow:

1. **Section A** consists of details of the respondent.
2. **Section B** multiple choice questions focus on possibility of stated factors to effect the effectiveness of the pipeline facilities projects of the company judged by the respective respondent.

In-depth interviews are conducted with selected respondent of the questionnaires. In order to collect data by direct interview, firstly list of more analytical and focused questions are to be developed. A digital voice recorder is to be used to maintain the accuracy of the interview results.

Questionnaire Form

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QUESTIONNAIRE

ON

"FACTORS AFFECTING EFFECTIVENESS OF MATERIAL SELECTION AND INSULATION MANAGEMENT OF PIPELINE ASSET"

Objective

1. To determine the foremost factors concerning effectiveness of facility management at topside facility pipeline in oil and gas industry.
2. To recommend possible application of the factor studied and effectively implement it to ultimately minimised or control the undesired event.

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Instruction:

1. Please fill in the space available and tick(/) in the respective box
2. All information's will be treated as **CONFIDENTIAL** and shall be used for academic purposes only.
3. All the data will be aggregated and no individual data will be published.
4. Please be considerate and honest in answering each question.

General

The questionnaire is divided into 3 sections, which are decided below:

1. Section A – General Information
2. Section B – Likehood of the factors to effect the effectiveness of the pipeline facilities

SECTION A: GENERAL INFORMATION

Name of Company/Organization:

Name :

Age :

Position :

Years of working experience :

No. of projects involved :

Gender : ☐ Male ☐ Female

Major field of study : ☐ Civil Eng. ☐ Mechanical Eng.

☐ Petroleum Eng. ☐ Chemical Eng.

☐ Business Administration ☐ Geology

☐ Finance & Accounting ☐ Management System

☐ Others (*specify*: ……..........………………)

SECTION B: LIKELIHOOD OF FACTORS TO OCCUR

Instruction: Based on your experience undergoing projects in your current company, please indicate the Likert Scales of respective factor that effect effectiveness of pipeline facilities to the statements below by ticking (✓) at the provided box.

Strongly Disagree (SD)	Disagree (D)	Neutral (N)	Agree (A)	Strongly Agree (VA)
1	2	3	4	5

I. People

		SD	D	N	A	SA
No.	**Factor**	**1**	**2**	**3**	**4**	**5**
1.	Quality of contractors work					
2.	Incompetence engineer lead the project					
3.	Technician attitude toward completing their work efficiently					
4.	Operating personnel do not follow the safe range operation					
5.	Using in- house personnel on core asset activities					
6.	All personnel should have training before handle the tasks					
7.	Managers should be money wise and make investment justification					

II. Process (Property)

		SD	D	N	A	SA
No.	**Factor**	**1**	**2**	**3**	**4**	**5**
8.	Scheduled maintenance services should be done properly					
9.	Technology used should be up to date					
10.	Design for pipeline facilities had to be reability proven					
11.	Assurance of quality and integrity of the asset					
12.	Operate pipeline facilities in safe manner					
13.	Assessing and verifying in place perfomance					
14.	Good partnership with material provider					
15.	Bonus given for reduction in execution time while all requirement fulfilled					

III. Environment

No.	Factor	SD 1	D 2	N 3	A 4	SA 5
16.	Should be dealt using appropriate practise standard					
17.	Identifying the environment of the platform such as in harsh water environment or calm water					
18.	Field data collection and management should be prepared for guidance					
19.	Inspecting the asset of environment influence by risk- based inspection					
20.	Using guideline provided for practise and operating procedure					
21.	Implementing safe work practise for every environment					
22.	No language barrier should present to communicate					

3.3.2 Secondary Data

Some of journals, paperwork and thesis related to this study are looked up as reference. Those materials are largely obtained from UTP's Information Resource Centre (IRC), library and e-Resources. Besides, general information from Oceaneering Services Malaysia projects.

3.4 Data Analysis Method

In order to determine the main factors affecting the efficiency of pipeline management on topside facility in the company, a qualitative measurement or ranking system is used in the analysis of this study. From the reasoning answers obtained from the respondents, a value of Average Index will be obtained by using the rating for the questionnaire, as follow:

1 –Strongly Disagree; 2 – Disagree; 3 – Neither; 4 – Agree; 5 – Strongly Agree.

The Average Index Formula:

$$\textbf{Average Index (AI)} = \sum (ß \times n)/N$$

Where, ß is weighing given to each risk factor by respondents

n is the frequency of the respondents

N is the total number of respondents

By the rating scale provided (Majid & McCaffer, 1997), as shown below:

1 = Strongly disagree (1.00 < Average Index < 1.50)

2 = Disagree (1.50 < Average Index < 2.50)

3 = Neutral (2.50 < Average Index < 3.50)

4 = Agree (3.50 < Average Index < 4.50)

5 = Strongly agree (4.50 < Average Index < 5.00)

The efficiency factor with highest Average Index score means that the factor is the most important or usually happens in Oceanering asset integrity pipeline projects. Subsequently, the lower Average Index score indicates that the efficiency factors are negligible.

3.5 Reporting

The report is to include the analysis on data obtained by classifying the efficiency factors into group of factor from the main key factor resulted from the survey performed. Further discussion towards these top two of each key factor efficiency with the possible strategies to manage them is also comprised in this report.

3.6 Gantt Chart

Table 2: Gantt chart for Final Year Project

No.	Detail/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project Work : - Upgrade the Questionnaires			◆											
2	Conducting survey in Oceaneering Company, screen out important data, calculate average index and start writing report.														
3	Submission of Progress Report							◆							
4	Project Work Continue: Find appropriate recommendation for factors discussed and check for its realibility.														
5	Pre- SEDEX										◆				
6	Submission of Draft Final Report											◆			
7	SEDEX												◆		
8	Submission of Technical Paper												◆		
9	Oral Presentation (Viva)													◆	
10	Submission of Project Dissertation (Hard Bound)														◆

Legend: Process ◆ Key Milestones

3.7 Key Milestone

Table 3: Key milestone for FYP2 for progress report

No	Activities	Completion Date
1	Completion of questionnaires preparation	11/10/2014
2	Conducting survey in Oceaneering	13/10/2014
3	Calculate average index for every factor available	20/10/2014
4	Screen out the highest top two factor for every key factor	26/10/2014
5	Finding the reasoning of all selected factor	29/10/2014
6	Start doing the progress report	30/10/2014
7	Completion of progress report	05/11/2014

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Data Gathering

4.1.1 Survey result of 'People' key factor on Oceaneering Services Malaysia

Table 4: Average index for each factor for 'people'

No.	Factor	Average Index
1.	Quality of contractors work	4.12
2.	Incompetence engineer lead the project	3.08
3.	Technician attitude toward completing their work efficiently	3.10
4.	Operating personnel do not follow the safe range operation	2.92
5.	Using in- house personnel on core asset activities	3.80
6.	All personnel should have training before handle the tasks	4.28
7.	Managers should be money wise and make investment justification	3.32

4.1.2 Survey result of 'Process' key factor on Oceaneering Services Malaysia

Table 5: Average index for each factor for 'process'

No.	Factor	Average Index
8.	Scheduled maintenance services should be done properly	4.44
9.	Technology used should be up to date	4.24
10.	Design for pipeline facilities had to be reability proven	4.12
11.	Assurance of quality and integrity of the asset	3.88
12.	Operate pipeline facilities in safe manner	3.84
13.	Assessing and verifying in place perfomance	3.68
14.	Good partnership with material provider	3.36
15.	Bonus given for reduction in execution time while all requirement fulfilled	3.76

4.1.3 Survey result of 'Environment' key factor on Oceaneering Services Malaysia

Table 6: Average index for each factor for 'environment'

No.	Factor	Average Index
16.	Should be dealt using appropriate practise standard	4.32
17.	Identifying the environment of the platform such as in harsh water environment or calm water	4.00
18.	Field data collection and management should be prepared for guidance	4.00
19.	Inspecting the asset of environment influence by risk- based inspection	4.28
20.	Using guideline provided for practise and operating procedure	4.08
21.	Implementing safe work practise for every environment	3.88
22.	No language barrier should present to communicate	3.68

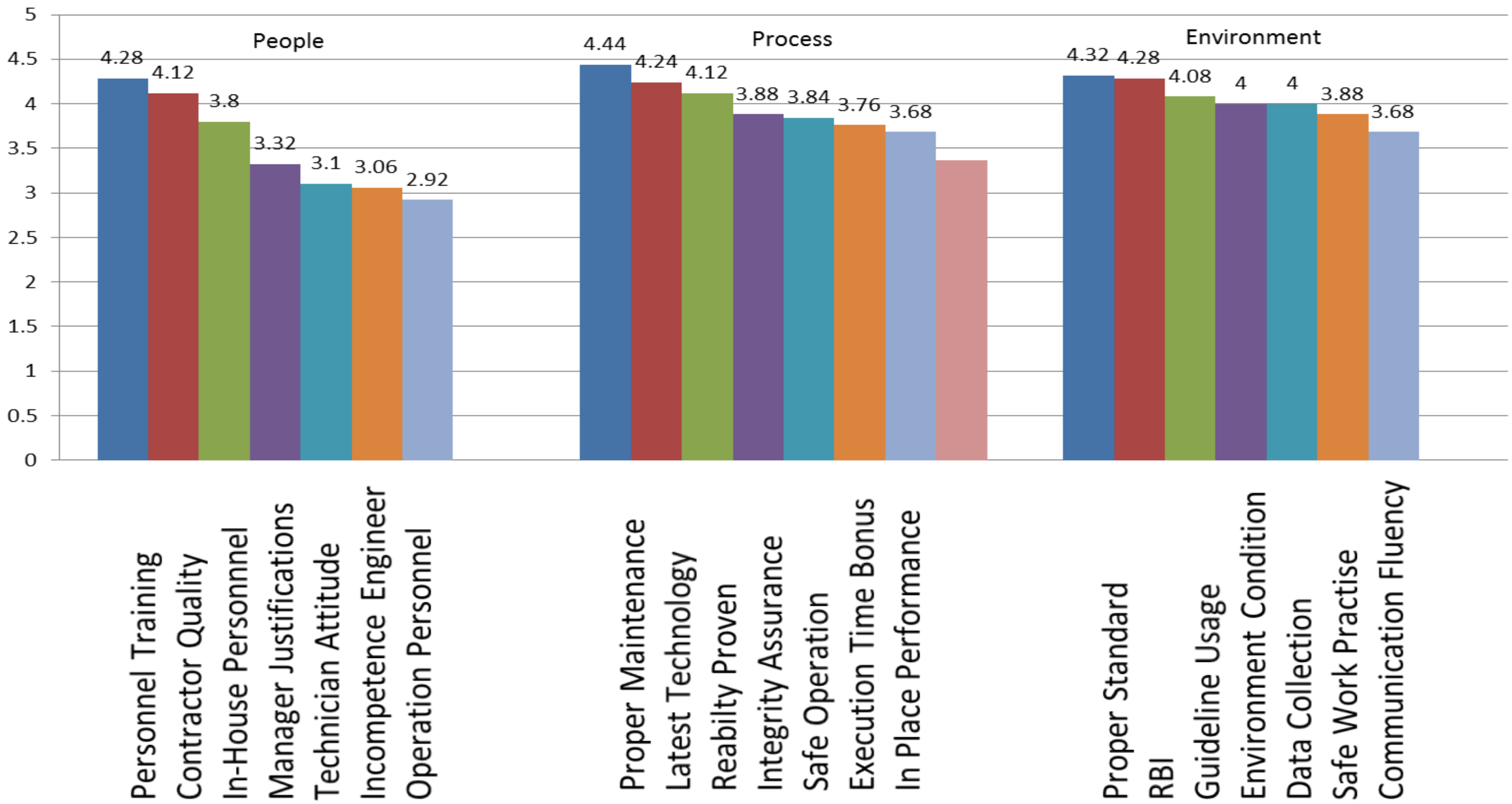


Figure 12: Bar Chart of Efficiency Factors

4.2 Discussion on the effectiveness factors

4.2.1 Analysis of 'People' key factor on Oceaneering Services Malaysia

Highest score for average index in term of people factor effectiveness is 4.28 out of 5.00. This mean most of the survey participants strongly agree that all personnel should have training before handle the task. This training should involve all parts of the major prerequisites of the specific task to form a well rounded engineer. Skill set of this beginner personnel should be more than textbook knowledge of the related topic but beyond that covering industries expectation. Effectiveness of insulation management and material selection can only be fulfilled as the right choice is made. For an example, the selection of the insulation that should be used depends on many factors. There are type of insulation material, thickness of insulation, condition of the pipeline, condition of the surrounding environment, length of insulation and placement of different layer of insulation in right order. In insulation material for heat conservation, there are many type of insulation use in oil and gas industry such as cellular glass and for temperature more than 180° C usage of mineral wool is recommended.

Second highest factor is the quality of contractors works which average index of 4.12 out of 5.00. Major number of respondent agrees and strongly agrees with this factor. Many smaller factors contribute to low quality of work done. They are miscommunication between the engineer and contractor, incompetence contractor rented to get insulation work done and contractor overlook on crucial step in completing their tasks. Common mistake done by the contractor as miscommunication took place. This miscommunication can occur because of contractor from outside company might different meaning for terminologies, process and material used. So cases such as placement of gasket or cone stop at the end of insulation usually occur. Some place does not need these two additional item to prevent water movement from outside such at high temperature pipeline. There are also different ways to install installation that overlook by the contractor which lead to ineffective insulation management. One of them is installation of metal cladding after the insulation by cellular glass. The purpose of the metal cladding is to prevent any movement of water into the insulation on rainy days or at harsh sea waves.

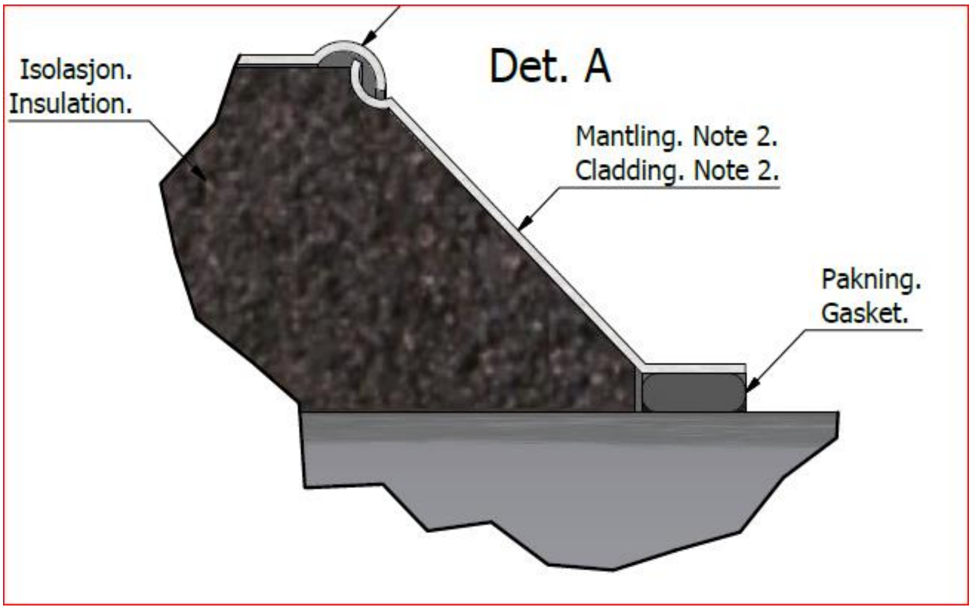


Figure 12: Metal Cladding Installation

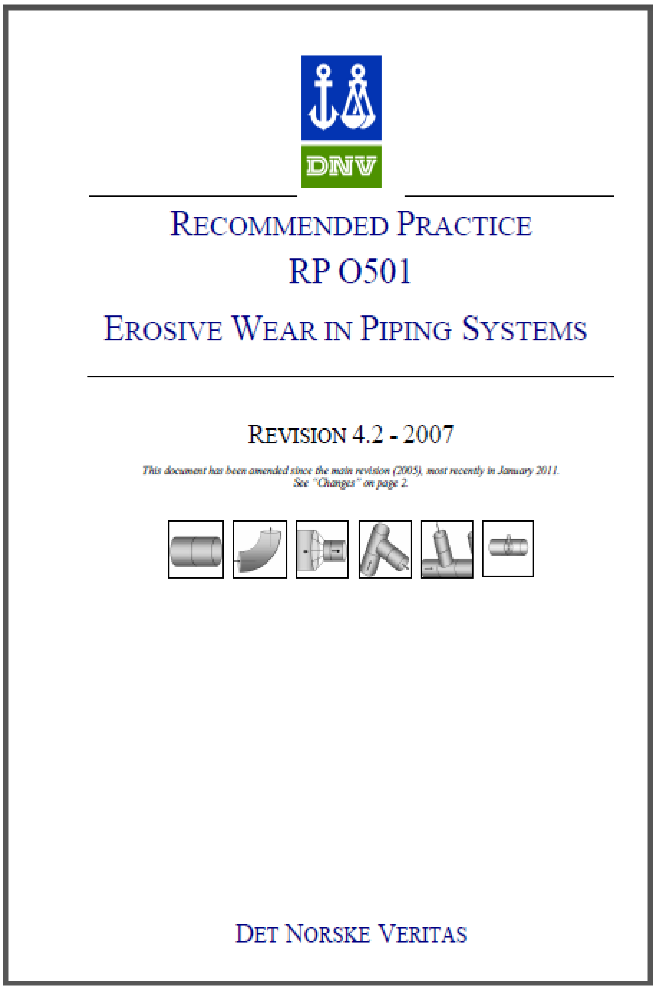
4.2.2 Analysis of 'Process' key factor on Oceaneering Services Malaysia

Highest score for average index for process key factor is 4.44 out of 5.00. The factor that affects the most effectiveness of the insulation management and material selection in this research survey is proper scheduled maintenance services. This schedule maintenance was generally based on criticality of the facilities to face problem or failure. Higher criticality means higher chance of failure to happen. All the pipeline facilities have different condition; environment and fluid transported which lead to criticality in having failure. Criticality assessment cover on how important is the certain pipeline in overall facilities, how & when failure will happen and how to prevent failure. Pipeline failure can be easy to observe or may be complex as if nothing observed that will lead to failure. These parameters will decide the duration or period of schedule maintenance to take place. However, the criticality can be reduced if proper material selection was prepared in such a way that better material is chosen to reduce failure.

Second highest factor affect effectiveness in term of process yield an average index of 4.24. It is the technology used in detecting failure should keep up with the technology advancement. Conventional way would be only by observing failure initiation occurrence outside of the pipeline or pigging method for inner part of the pipeline. Both ways was ineffective as failure mode could be in rapid progress as susceptible model with instant failure while pigging require shutdown of the pipeline facilities or only in workover period. Latest technology of Computed Radiography Testing (CRT) could detect anomalies such as corrosion and erosion inside pipeline insulation or inside pipeline itself. Calibration needed to make sure all the reading given is true. Radioactive rays will penetrate the chosen part of the pipeline and all the reading will be computed and result with certain graph. This method is cost effective and time effective. As example, carbon steel is susceptible to many types of corrosion such as pitting from bacterial activity in seawater and hydrogen sulfide at inner part of the pipeline. Instant failure might occur if no immediate action to prevent failure. CRT will be used to detect parts of the pipeline that suffer pitting attack. CRT can also detect corrosion under insulation that primarily occurs due to water seeping into the insulation.

4.2.3 Analysis of 'Environment' key factor on Oceaneering Services Malaysia

In environment key factor, the highest average index is 4.32 out of 5.00. The factor selected was using appropriate practice standard in handling environment conditions. This means that most of the respondents mostly agree and chose parameter of agrees and strongly agrees in the survey conducted. There are two phase in applying practice standard which are before running the designed pipeline and after applying the designed pipeline. This factor strongly related in phase of before designing pipeline asset. This designed include the most crucial factor which are insulation management and material selection. Before any decision made in designing pipeline field data collection and management should be prepared for guidance. For example, in Norway the environment of offshore structure is very harsh with huge waves and facing seasonal climate change while in Malaysia the environment either at onshore or offshore have no large deviations. Based on field data, all fluid produced and transported will be reviewed first for its critical content such as acid or sand production. Selection of the suitable material and insulation management will take this problem into consideration. In order to tackle this problem most of oil and gas company refer to certain practice standard. In case of acid transportation in the pipeline mixed with sand production material selection will be the first important point. Usage of high resistant pipeline to acid should be selected with suitable thickness calculated from erosion rate. In Malaysia, standard use is Petronas Technical Standard (PTS) while in Norway use Det Norske Veritas (DNV). These two standards will guide the way of certain company completing their base case scenario.



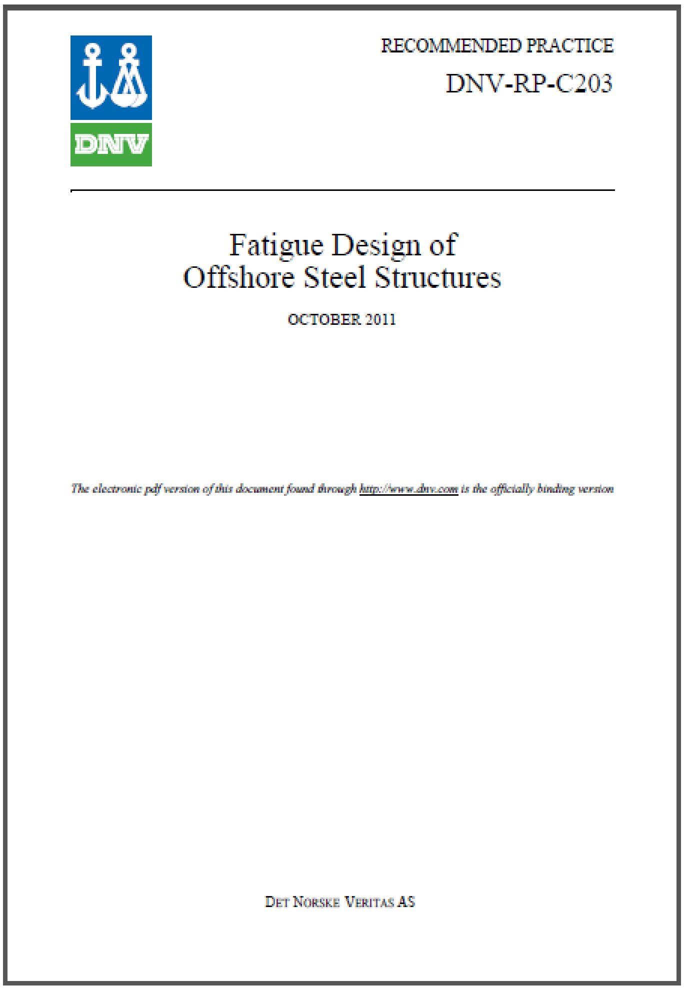


Figure 13 and 14: Examples of Practice Standard Used

Second place dominated by factor of inspecting the asset of environment influence by risk-based inspection with average index value of 4.28. This factor is after designed pipeline facilities implemented and running. Guideline or standard practice used to run this facility in safe range. All operating procedure should be followed to prevent any failure. In developing this RBI analysis, it is essential to identify and define the expected type of degradations that are potentially occurs in the pipeline system. Later this information will be used to evaluate the Probability of Failure (PoF) and impact on the consequence of failure (CoF). The PoF evaluations distinguished between internal, external, fatigue and other damage mechanism. The PoF value will be assigned on each system which will consider general corrosion, CO_2 corrosion, H_2S corrosion and cracking, microbial induced corrosion (MIC), erosion, atmospheric corrosion, external stress corrosion cracking, corrosion under insulation, corrosion under supports and sand erosion.

The Oceaneering RBI method for topsides static mechanical and piping uses semi quantitave approach which comprising three stage analysis process, namely Prescreening, Detailed Assessment and Inspection Planning. This method facilitates the development of an inspection planning that is designed to manage the risk associated with loss of containment of topside pressurized equipment and piping. Goal of implementing risk based inspection in material selection and insulation management are to improve the margin of pipeline safety by using inspecting resources in the most cost effective manner and focus the inspection effort on pipeline or insulation part that predicted to give high risk and reduce the effort on low risk part.

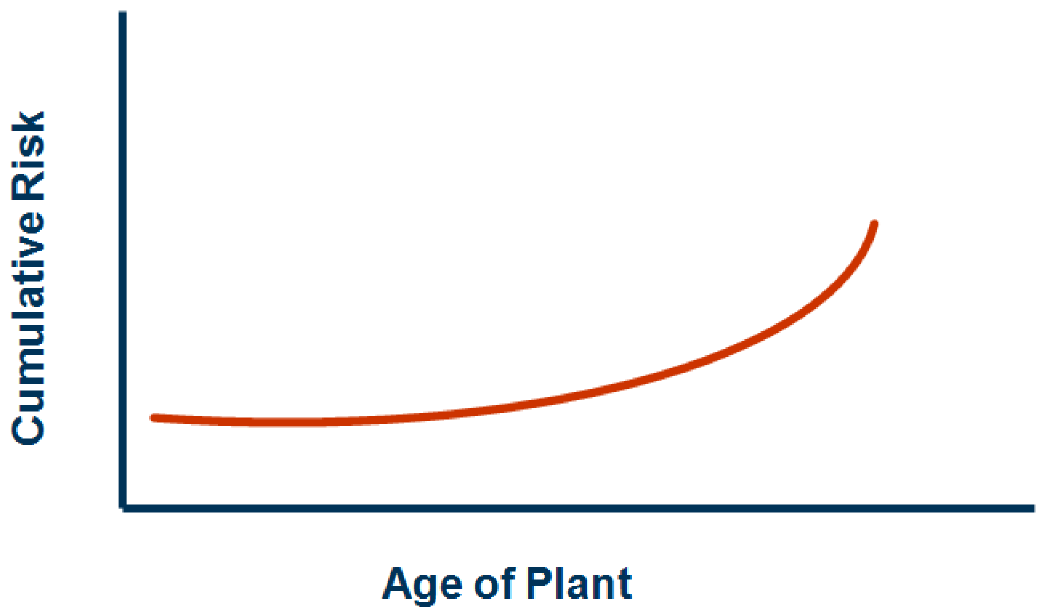


Figure 15: Risk of Failure in Aging Pipeline and Insulation Management System

CHAPTER V

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Based on discussion presented above, this survey has 3 main key factors that affect the effectiveness which based on people, process and environment in Oceaneering Services Company. Two top average index from were discussed in depth. In people based effectiveness two factors that agrees among the respondent are quality of contractor work and personnel involve should undergo various training before handling tasks with average index of 4.12 and 4.28 respectively. Oceaneering Company taken this matter highlighted into consideration to be prevented and result in yielding more effectiveness in handling insulation management and material selection. Personnel required to complete any task shall be given training in all perspective. Oceaneering Company usually sends their workers at international training such as Technolgy Software Advancement to learn internationally used SOLV technology. Oceaneering also send workers to take engineering exam such corrosion exam and required skill such as scaffolding. In term of quality of contractor work, Oceaneering Company's engineer shall work together with contractor to make sure all work done achieve effective installation.

In process key factor perspective, the most important factors are the scheduled maintenance should be done properly and the technology used should be up to date. Both of the factors yield average index of 4.44 and 4.24 respectively. In term of scheduled maintenance, all required maintenance should be taken care immediately with high degree of efficiency so that no side effect of poor job execution resulted. Oceaneering Company takes care of scheduled maintenance based on selective preventive maintenance that means higher risk occurrence will be treated regularly. Latest technology should be introduced and implemented to get better result of inspection of pipeline so that better prevention can of degraded pipeline can be detected even in complex area. Computer aided software should also be updated to make work flow more efficient and time effective.

Third key factor is the influence of environment to the effectiveness of the pipeline insulation and its material selection. Two highest average index factors are the way of dealing with environment using appropriate practice standard and inspection of asset of environment influence by risk based inspection. There are many practice standard used in oil and gas industry. To choose the best practice will be the problem here but the most important thing is that all the design of pipeline and its insulation management should be more than minimum requirement. As minimum requirement was fulfilled problems could be prevented as long the guideline was followed. Operation of pipeline system shall be conducted along the assessment and performance verification by inspecting using risk based inspection. Measures will be taken to prevent failure and prolong the life cycle of pipeline integrity. Advantages in applying risk based inspection are:

- increased operability through increase in asset availability and reduction of pipeline shutdowns or abandonment
- reduced risks of failure and associated consequences, including safety and environmental impact
- inspection optimization, through optimization of number of items and positions to be monitored and frequency of inspection
- monitoring optimization, through the identification of most critical positions and parameters to be monitored

All these factors affecting the effectiveness of insulation management and material selection is important to go through in order to maximize the effectiveness of pipeline assets that could gone wrong and made a huge loss of money of investments upon failure. In oil and gas industry, failure of implementing best techniques of protecting pipeline asset from corrosion cost nearly $170 billion a year in US industries alone.

Table 7: Recommended strategies can be implanted with specific factor

Key Factor	Factor	Recommended Strategies
People	Quality of contractor work	-Briefing from engineer in charge for insulation management and material selection -Give P&ID diagram instruction with labelling to the contractor
	All personnel should undergo specific training for specific task	-Choose a calibre person to undergo specific training -Implement bonding status to employee that undergo training, exam or skills attended
Process	Scheduled maintenance should be done properly	-Require perfect communication of engineer with the operator -Tag all part done so that no part of piping inspection left behind
	Technology used should be up to date	-Implement usage of new technology or software with multipurpose, efficient and easy to use -Take risk of investing in new technology with proven to be reliable
Environment	Should be dealt using appropriate practise standard	-Use appropriate standard practice in specific condition faced -Compare between standard and use the most reliable and effective
	Inspecting the asset of environment influence by risk- based inspection	-Tabulate of risk can be separated based from its criticality and selective preventive maintenance can be conducted

5.2 Recommendation

Increment of number of respondent

There might be deviation of respondent answer in survey conducted as the number increased. This is what the survey should be as the opinion of people might differ based on field of study and working experience. Increment of respondent number enable to the researchers to come up with precise factor in affecting pipeline integrity. Two way investigation should also implemented as contractors and engineer working together in achieving same goal.

Investigate more company with same related field

In this research, only one service company is involved. This usually narrows down the key factor of efficiency that only happens in that particular surrounding of the company. Although investigated factors are not entirely wrong, precise problem could be identified with more company used to complete the research survey. Besides that, respondent of the survey should still working in particular project so that all the problem encountered shall be remembered exactly.

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Appendix

1. Key Data for Insulation System

Insulation class	Insulation materials	Jacket material	Other comments/ build-up
Class 1 Heat conservation	Cellular glass Mineral wool at temp. higher than 180 °C	Stainless steel/al or non-metallic weather-proofing membrane	
Class 2 Cold service insulation	Cellular glass	Stainless steel/al or non-metallic weather-proofing membrane	Vapour barrier
Class 3 Personnel protection	Either class 1 to class 9 or perforated sheet metal guards	In accordance with class 1 to class 9, as applicable	Perforated guards of stainless steel to be preferred insulation method. If perforated guards is used, it shall be designed so that the guards/jacket temperature do not exceed 70 °C
Class 4 Frost proofing	Cellular glass	Stainless steel/Al or non-metallic weather-proofing membrane	Vapour barrier See 8.1
Class 5 Fire proofing	Cellular glass + AES - or mineral wool, when necessary	Stainless steel	Insulation materials are dependant on protection requirements, and shall be accepted in writing by client for each case
Class 6 Acoustic insulation	Cellular glass + AES – or mineral wool heavy synthetic sheet	Stainless steel/Al or non-metallic weather-proofing membrane	30 mm to 40 mm cellular glass + 25 mm wool + metallic jacketing (or aluminium foil + non-metallic jacketing)
Class 7 Acoustic insulation	Cellular glass + AES – or mineral wool heavy synthetic sheet	Stainless steel/al or non-metallic weather-proofing membrane	30 mm to 40 mm cellular glass + 38 mm wool + heavy synthetic sheets + metallic jacketing (or aluminium foil + non-metallic jacketing)
Class 8 Acoustic insulation	Cellular glass + AES – or mineral wool heavy synthetic sheet	Stainless steel/Al or non-metallic weather-proofing membrane	30 mm to 40 mm cellular glass + 38 mm wool, + 2 x heavy synthetic sheets + 25 mm fibres + 2 x heavy synthetic sheets + metallic jacketing (or aluminium foil + non-metallic jacketing)
Class 9 External condensation	Cellular glass	Stainless steel/Al or non-metallic weather-proofing membrane	Vapour barrier