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Decision-Making Model for Facility Management Prioritization and Optimization in O&G Service Companies

by

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ABSTRACT

Today's oil and gas industry finds itself in the deepest financial crisis on record, with profitability and cash flow at unsustainable levels for most oil and gas operators which in turn has created an equally dramatic situation for the service companies. To deal with these issues, services companies have implemented plans to reduce cost, improve maintenance efficiency, productivity and increase asset availability through what is known as asset management. In this study the focus was placed into the asset class related facilities and real estate.

As part of the coordinated activities to manage assets, organizations must make decisions which affect the state of their assets for each of the lifecycle stages. Taking decision in facility management have been identified as a major challenge due to the lack of systematic approaches that can be used in the decision-making process.

This study seek to develop a decision-making model for facilities management within oilfield service companies as a main objective. In order to achieve this goal, five sub objectives were proposed, looking into: discuss the current situation and related problems, define and discuss possible options/solutions, establish a model to discriminate among possible options, define decision-making criteria and assess how the possible options fulfil/align with the criteria and apply the model to find the best alternative for asset optimization. The study case was limited to the facilities used by Schlumberger Wireline in Venezuela.

The thesis was divided into five chapters namely: introduction and background information, literature review, case study and implementation on the decision model, discussion and conclusions and recommendations for future research.

The implementation of the case study was possible through a group of individuals designated as part of the decision-making group. The evaluation criteria was built into three main elements that were assessed in each facility, the elements were: Feasibility, Acceptability and Vulnerability. The final was made using a decision tree and a weighted criteria chart suggested by the subject expert matters in the team.

The optimal solution presented the alternative of using one facility as main delivery centre for the operations in the whole country and other solution for the rest of the facilities. The study finalize presenting the thesis and result discussion, main findings, challenges and suggestions for future researches.

Key Words: Asset management, service companies, oilfield, oil and gas, facility management, decision-making model, optimization.

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Eduardo Galue Campos

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LIST OF ABBREVIATIONS

CEO – Chief executive officer

PAS – Publicly Available Specification

NS - ISO – Norsk Standard International Organization for Standardization

UiS – Universitet i Stavanger

NAMS – Australian National Asset Management Strategy Committee

FMAD – Flexible Asset Maintenance Decision-Making

SLB – Schlumberger

VEN – Venezuela GeoMarket

SMART – Specific, measurable, attainable, relevant and trackable.

SWOT – Strength, Weaknesses, Opportunities, Threats

CHAPTER 1: INTRODUCTION

This chapter introduces the research topic presented in this dissertation. It provides an overview of the research problem and background, and identifies the motivations for pursuing this work. It then states the research aim and objectives, and concludes how the study and chapters are organised.

1.1 Background

Industry terminology defines a service company as a business that generates income by providing services instead of selling physical products (Macintyre, Parry et al., 2011). Looking more specifically at the oil and gas industry, a service company can be defined as a company that “provides the infrastructure, equipment, intellectual property and services needed by the international oil and gas industry to explore for, extract, and transport crude oil and natural gas from the earth to the refinery, and eventually to the consumer” (KPMG, 2016). Within the industry, Schlumberger stands as the world's largest and most recognized service companies, which has been in the market since 1920 and in South America since 1929.

In 2016, Schlumberger CEO, Paal Kibsgaard, talked at great length about the current condition of the industry and the difficulties the company faces at an investors conference:

> Today’s oil and gas industry finds itself in the deepest financial crisis on record, with profitability and cash flow at unsustainable levels for most oil and gas operators which in turn has created an equally dramatic situation

> for the service companies. The apparent cost reductions seen by the operators over the past months are not linked to a general improvement in efficiency in the service industry. They are simply a result of service-pricing concessions as activity levels have dropped by 40-50% and most service companies are now fighting for survival with both negative earnings and cash flow.

To deal with the current issues, services companies have implemented plans to reduce costs and improve maintenance efficiency and productivity while also increasing asset availability through what is known as asset management, which stands as a type of action plan to streamline operations. According to the Publicly Available Specification (PAS) standard 55 (2008) is defined as "systematic and coordinated activities and practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their lifecycles for the purpose of achieving its organizational strategic plan." In essence, it serves as an expanded view of how assets are planned for, used, maintained, and ultimately retired/disposed as presented.

When working towards maximizing asset management, physical assets are positioned in the following five classes:

- Real Estate and facilities (offices, schools, hospitals);
- Plants and Production (oil, gas, chemicals, food, electronics, power generation);
- Mobile Assets (military, airlines, trucking, shipping, rail);
- Infrastructure (railways, highways, telecommunications, water. electric and gas);

- Information Technology (computers, networks, software, auto discovery, service desk).

Among all the assets types, facilities have been able to serve as a leveraging agent within business transformation. Campbell (2011) expresses that facility management typically accounts for at least 15% of a company's general cost and when properly managed can generate savings from 5 to 20 percent of total expenditure on this matter. Moreover, whether the influences are regional, national, or international, experience from major organizations has shown that the most common reasons for improvements in facility management are:

- Reducing operating costs: as part of an organization-wide cost-saving initiative.
- Improving service quality: often as a reaction to changes to the business that mean its operations no longer meet market's need.
- Increasing service consistency: to allow for support services to operate more streamlined with the other business functions.
- Increasing focus on the core business: thus avoiding management distraction on non-core activities.
- Mergers and acquisitions: that call for rapid and effective rationalization.
- Sustainability: and the drive to reduce the business's' footprint.

As part of the coordinated activities to manage assets, organizations must make decisions which affect the state of their assets for each of the lifecycle stages, at the same time managers need to understand that any decisions it is not independent and can impact subsequent events (Amadi-Echendu, 2012).

Effective decision-making must be achieved through evaluating options as well as monitoring and analysing information regarding key events and constraints that could affect asset performance. Consequently, the general organization performance must be considered and not only cost or predetermined outputs. When looking into assessing only outputs, the processes and results tends to underplay the role of how decisions are made, which at the end, can impact the quality of the decision-making process, making it subjective instead of objective, thus not considering all the stakeholders influences (Barrett & Baldry 2003).

1.2 Problem and Challenge

Among all the different department and services, we will focus on wireline, the cable that is used to lower and raise tools and other equipment within a well shaft. Schlumberger's wireline service in Venezuela has been divided into two main zones to cover all production fields in different states: West (Ciudad Ojeda and Barinas) and East (Maturin). In order to facilitate these services, a total of three operational facilities have been used to fulfil the operations.

Those facilities were actively operating until 2015, when low oil prices caused a reduction in activity, and the profitability was seriously affected by high maintenance costs. Based on the current market conditions, Schlumberger has been looking to efficiently rationalize large facility assets and reduce its footprint as a measure to control costs and expenses to regain profitability.

The way service companies in the oilfield business manage their decisions with large asset, such as facilities, has been identified as a major challenge. When it comes to industrial assets (i.e. tools, equipment, production facilities) decisions are made based on maintenance inputs, data, evaluation applying available asset management frameworks, but when decisions involved large assets, such as facilities, decisions tend to be related to cost mainly due to lack of supporting data and historic records. In this case, managers look at the most convenient solution without taking into consideration all internal and external stakeholders.

This study will focus on facility management, looking at the convergence of three operational bases, to evaluate and create a decision model that can help oversee all aspects related to the options of disposing, selling or continuing its wireline operations with a rearranged configuration. The author will then provide an evaluation that can aid in determining the most suitable option to maximize the beneficial outcomes for the company.

1.3 Scope of work

The scope of this study has the following main objectives:

- Design a decision-making model for facilities management within oilfield service companies.

In order to achieve this main goal, the following sub objectives have been proposed:

- Discuss the current situation and related problems.

- Define and discuss possible options/solutions.
- Establish a model to discriminate among possible options.
- Define decision-making criteria and assess how the possible options fulfil/align with the criteria. (Assess weights of the criteria, uncertainty in the assessment, etc.)
- Use the model to find the best alternative for asset rationalization.

1.4 Research approach and methods

The work in this thesis is based on relevant academic literature on the subjects discussed, namely published books and papers in addition to company specific documents obtained from Schlumberger.

Moreover, relevant lecture notes and presentations given by the lecturers at the University of Stavanger (UiS) throughout the education leading up to this master's degree thesis. All the references serve as academic background for many of the considerations presented herein.

1.5 Delimitations

The scope of this thesis is not to present any scientific research results per se, but it will evaluate asset management theory in order to explore decision criteria models to asses' facility management decisions. In terms of location, the case study have been limited to the company Schlumberger Venezuela and the operational bases operating in the country, located in Barinas, Ciudad Ojeda and Maturin. In terms of time, the project will be presented from evaluation to implementation, but will not be able to measure results; neither establish the performance indicators, as the final plan will be executed in 2017.

1.6 Structure of the thesis

The thesis have been divided into five main chapters briefly described as followed:

Chapter 1: Consists of sections related to the outlining of the background, scope, delimitations and objectives of this thesis.

Chapter 2: Describes the literature review of related topics such as assets, asset management, lifecycle asset management, facility management and decision-making.

Chapter 3: Is dedicated to the case study of Schlumberger Wireline Venezuela, starting with some background information from the company, and continues with the implementation of a decision-making model to systematically make decisions about facilities management during the last stage of the lifecycle.

Chapter 4: Presents a discussion on whether the objectives of the scope of work were met during the work, findings, learning areas and finally a discussion of challenges encountered during the execution of the investigation. This section is concluded with the conclusion and recommendations summing up the work of the thesis in a comprehensive way.

Chapter 5: Present the recommendations for future research on this subject and other similar and relevant topics.

1.7 Chapter 1 Summary

The introductory chapter lays the foundation of the thesis by identifying key issues related to asset management, decision-making and facility management. It outlines the background information to understand the research context. Decision-Making for facilities in their final stage of the asset management cycle, having been identified as a major challenge for most service companies, mainly due to the focus on maintenance and revenue generating assets than on large assets. The proposal for the study is to design a decision-making model that can support managers on applying systematics procedures to assess impact on facility management decisions. Subsequently, Chapter 2 will now conduct a theoretical review of some essential literature and previous research on the topics discussed above.

CHAPTER 2: LITERATURE REVIEW

In the past, asset management was most often described in terms of maintenance management with an exclusive focus on schedules, programs, procedures, and tasks necessary to optimize the uptime of an organization's equipment. Today, with advancing theory and focus, it now requires the active life-cycle management of the major assets and components from design to disposal, to achieve differentiation in the market, which can help a company keep the upper hand on their competition.

The literature review seeks to establish a broad understanding of asset management by providing necessary background information to then support the development of decision-making models in facility management.

This chapter is structured by first conducting a brief literature review of the concepts of asset management based on actual theories and standards. This will be followed by a review on the decision-making for facilities management and the overall decision-making processes from relevant research. The final part will present options for the development of a decision-making model to help achieve better asset rationalization when dealing with facilities and long-life assets within Schlumberger Wireline Venezuela. The chapter ends with a discussion and summary.

2.1 Assets and Asset Management Theory

Before diving deeper into to the details of asset management, it is important to establish the meaning of 'asset' within this study. A starting point is the definition from the British Standards Institution within their widely adopted Publicly Available Specification (PAS) 55 where it defines an asset as: “plant, machinery, property, buildings, vehicles and other items and related systems that have a distinct and quantifiable business function or service” (2004).

Likewise, the Norsk Standard NS-ISO 55000, (2004) defines an asset as an “Item, thing or entity that has potential or actual value to an organization.” The value can be tangible or intangible, financial or non-financial, with the consideration of risk and liabilities included. The asset’s value can be positive or negative at different stages of the asset life.

The bases of these definitions are the functional/value aspect of the assets, as well as their “tangible” nature. For the purpose of this thesis, the definition from different authors has been brought together as follows: a plant, machinery, property, building, vehicle or other items and their related systems that provide a distinct and quantifiable tangible or intangible function or service to a customer in the oilfield business.

PAS-55 (2004) describes that physical assets are positioned in the following five asset classes:

- Real Estate and Facilities (offices, operation buildings, shops);
- Plants and Production (oil, gas, chemicals, pharmaceuticals, food, electronics, power generation);
- Mobile Assets (military, airlines, trucking, shipping, rail);
- Infrastructure (railways, highways, telecommunications, water and wastewater, electric and gas distribution);

- Information Technology (computers, routers, networks, software, auto discovery, service desk).

For the purpose of this investigation, the focus will be on the real estate and facilities asset class.

2.2 Asset Management

The British Standards Institution's PAS 55 defines asset management as the "systematic and coordinated activities and practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their lifecycles for the purpose of achieving its organizational strategic plan" (2004). A strategic plan in this context is the overall long-term plan for the organization that is derived from and embodies its vision, mission, values, business policies, objectives and the management of risk. Together these definitions encompass the entire lifecycle and the physical nature of the assets.

Meanwhile, the Norsk Standard NS-ISO 55000 defines asset management as the "coordinated activity of an organization to realize value from assets. Realization of value will normally involve a balancing of costs, risks, opportunities, and performance benefits" (2004).

Both definitions have two recurrent aspects:

- Coordinated Activities: typically this involves a trade-off between several optimization criteria. The different activities that are mentioned are not stated explicitly, however, engineering, risk management and financial management are those that are most often considered.

- A Real Value / Purpose: one definition focuses on the achievement of a strategic plan, the other introduces the notion of realized value.

Taking these aspects into consideration, asset lifecycle can be referred to as the strategy, plan, design, procurement, operating, maintaining, repairing, modifying, replacing and the decommissioning/disposal of assets. There are different types of assets that integrate the asset management system in an organization. Examples are physical assets, human assets, information assets, financial assets and intangible assets. Although there is interdependency between the different assets, this research focuses on the evaluation of physical assets (Campbell et al. 2011).

2.3 Key Principles of Asset management

According to the Institute of Asset Management (2016), there exist a key set of elements that define “good asset management.” These key elements are also highlighted by Woodhouse (2010) and the PAS 55 (2004), which stresses that integration should be the centre of the other elements. These key elements include:

- Integration: at the heart of good asset management lays the principle that all parts and elements of the organization affect each other through complex interactions. There exist a need for the organization to function as a whole rather than a set of different departments generally moving in the same direction.

- Systematic Approach: the concept of an asset management system must be applied on all levels and parts of the organization in order to enable good asset management.
- Systems-Oriented: good asset management looks at the assets from their natural systems context in order to be able to generate value.
- Multi-Disciplinary: asset management from a holistic point of view crosses both departmental, disciplinary and geological boundaries and evolve around generating the best possible value, independently of the nature of the value. This value can take many forms and will often vary within the different parts of the organization.
- Sustainability: there must be established plans that ensure optimal value-generation throughout the lifecycle of the asset, at the same time, including important aspects related to environmental issues.
- Risk-Based Assessments: being able to plan for, manage and understand implied risks in decision-making processes is an important factor of good asset management.
- Optimization: Good asset management includes being able to balance objectives so that cost, performance and risks can be balanced in both the short and long-term.

2.4 Key benefits of Asset Management

Asset management relates to having the ability to reach organizational goals and aims through effective and efficient value making through managing the assets of an organization in an optimal way. The form and nature of this value making is dependent of the organization and its assets, but ISO-55000 (2014), has identified the following nine key benefits that can be achieved through the application of asset management:

- Improved financial performance
- Informed asset investment decisions
- Managed risk
- Improved services and outputs
- Demonstrated social responsibility
- Demonstrated compliance
- Enhanced reputation
- Improved organizational sustainability
- Improved efficiency and effectiveness

From the diverse nature of these benefits, it can be seen that in order to achieve them, it is required that all departments and parts of the organization contribute equally and remain integrated within the search to achieve a business' objectives.

2.5 Facilities Management Theory

Campbell (2011) expresses that facilities are often one of the largest items on both an organization's profit and loss account and its balance sheet. The research shows that by moving from the historical method of dealing with facilities to an approach that takes account of the current industry knowledge and best practices, businesses can improve value for money and reduce their costs by up to 20% while still improving services and their consistency of performance.

The international Facility Management Association (2016), has defined facility management as a practice that encompasses multiple disciplines to ensure functionality of the building environment by integrating people, places, processes and technology.

Barrett & Baldry (2003) definition is commonly cited and will be heavily relied on within this investigation. Their research defines facility management as "an integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organization in order to create an environment that strongly supports the primary objectives of the organization" (2003). Meanwhile, previous research by Lewis (1999), defined facility management as "the effort expended to provide complete operations and maintenance service support so that a physical facility (buildings, equipment, machinery, system, and grounds) may operate at an optimum lowest overall total cost."

All definitions highlight the integration of activities/operations, but only Barret & Baldry's stress the importance of integrative, interdependent disciplines whose overall purpose is to support the organization in the pursuit of its business objectives/goals. A different perspective but also relevant was introduced by Lewis in his literature establishing different concepts between public and private organizations and stresses the financial view of facility management.

Looking at the services that are needed for facilities management, they are often categorized as either “hard” or “soft,” with the majority of suppliers having grown from either a technical hard, or, a services-oriented soft base.

The major hard categories include the following:

- Building maintenance
- Mechanical and electrical maintenance
- Minor projects

Soft facilities management services include the following:

- Cleaning
- Pest control
- Catering
- Manned security
- Office services
- Waste disposal

Facility management is a changing discipline that continuously adjust to internal and external necessities. Campbell et al. (2011), explain that based on experience the following are the most common reasons for changes in the way facility management is handled:

- Reducing operating costs, as part of an organization-wide cost-saving initiative;
- Improving service quality, often as a reaction to changes to the business that mean its operations no longer meet the business need;
- Increasing service consistency since the support services should operate in a similar manner to the other business functions;
- Increasing focus on the core business, thus avoiding management distraction on support and noncore activities;
- Mergers and acquisitions – with the consequent drive for rapid and effective rationalization;
- Sustainability – with the need to reduce carbon footprint.

For the purpose of this investigation, the focus will be on managing facilities and looking at the various options in order to reduce operating cost for an effective rationalization and the implementation of a new strategy due to the excess of facilities costs that resulted from recent mergers and acquisitions.

2.6 Facility Managers

Lewis (1999) defines a facility manager as the responsible individual in a public or private organization to whom top management looks to coordinate and control all the activities and services required by internal and external stakeholders.

The responsibilities for facility managers in service companies are:

- Facility planning;
- Engineering and design of new facilities;
- Engineering and design of modifications to facilities;
- Engineering and design in support of maintenance and repair functions;
- Construction of facilities and installation of equipment;
- Maintenance and repair of facilities, systems, and equipment;
- Evaluation of proposals for replacement of facilities and equipment, which are based in whole or in part on maintenance, energy, or utilities savings.

2.7 Decision-Making in Asset Management

As part of coordinated activities to optimally manage assets, organizations must make decisions that affect the state of their assets for each of the lifecycle stages understating that these decisions are not independent. Coordinating these decisions and understanding the impact of one decision's outcome on subsequent decisions is vital to efficient asset management.

Amadi-Echendu et al. (2012), described that asset management decisions such as choosing to replace or maintain an aging asset or infrastructure, are critical to ensure that organizations maximize the performance of their assets. These decisions are only as good as the information which supports them and the decision-making criteria used. Making decision on poor-quality information can result in great economic losses. The authors also stress that effective decision-making can be achieved through monitoring and capturing information regarding vital events, factors and constraints, which affect asset performance and consequently organizational performance (2012). Thus, considering long-life assets, such as facilities, a successful asset management decision-making process must effectively handle multiple timescales. The relationship among asset management, decision-making, timescales and information can be described using a multi-scale decision-making model below:

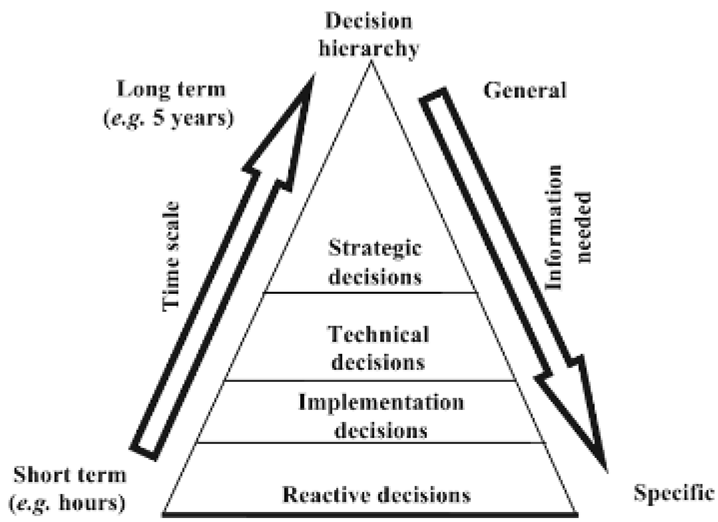

Figure 1: Multi-Scale decision-making conceptual model, (Amadi-Echendu et al, 2012).

Amadi-Echendu et al. (2012), introduced a classification of different types of decisions based on the time required to get solutions. The work highlighted that an asset management decision-making process has to enable decisions makers to deal effectively with multiple decision criteria and interactions. As seen in the figure above, with respect to time scale, asset management decisions can be classified into four categories: strategic decisions, technical decisions, implementation decisions and reactive decisions.

These four types of decisions have very different timescales ranging from years to minutes as well as different levels of information required to make them – from more general to very specific in the case of reactive decisions. Strategic decisions need to be made over long periods of times, such as annually, while routine decisions (technical and implementation) are needed in the medium term, such as monthly. Finally, urgent decisions (reactive), may need to be made within a shorter periods like hours or even minutes.

Other authors have developed a general classification of asset management decision types with a different approach. Woodhouse (2010), suggested six different classification areas for asset decisions, namely:

- Project cost / benefit / risk evaluation;
- Asset replacement and lifecycle costing;
- Planned maintenance strategy;
- Inspection testing and condition monitoring;
- Shutdowns and work grouping;
- Spares and materials strategies.

The reasoning behind the selection of these six areas appears to be based on the author's own experience in consulting work over an extended period of time. The nominated decision classification areas correspond to problems commonly experienced by assets managers within organizations.

Woodhouse (2005), clustered the different approaches to decision support into some simple groups. The two main categories of decision-support aids are considered helpful in:

1. Detecting, diagnosing or characterising the problem;

2. Choosing, justifying or optimally timing/targeting the appropriate measures.

The first category can be helpful when dealing with condition monitoring, data collection, inspections, maintenance history, reporting, pattern recognition and root cause analysis tools. This category can be broken down into two stages: the detection and the diagnosis. The second category of decision support is more complex and involves methods to help choose between different actions to evaluate their cost/benefit/risk impact, and to determine when or how much intervention is necessary. In some cases, there are simple, common-sense solutions to encourage greater consistency or more appropriate choices. For more complex solutions or significant calculations, modelling or assessments may be necessary. Figure 2 provides a summary of the main groupings of requirements.

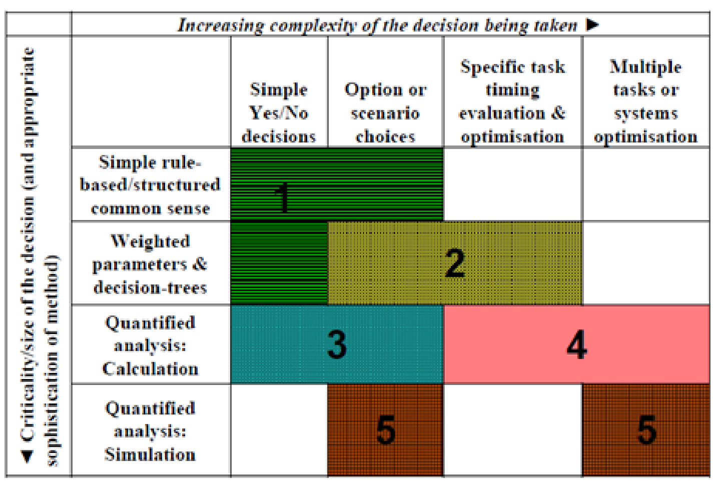

Figure 2: The Structure of Decision Complexity and Criticality (Woodstock, 2005)

The figure above demonstrates that the more complex and critical the decision, the more care and rigour are justified in evaluating options for optimising the appropriate actions. For example, in the case of engineering assets, depending on type of failure, it might be necessary to run simulations to evaluate the behaviour of different components at different environmental conditions such as temperature or vibration. In the case of facilities, depending on problem's complexity, the decision can be taken using structured common-sense or weighted parameters and with a decision tree.

It must be noted that decision-making process in asset management differs from traditional management practices, which is reflected in work by Flintsch & Bryant (2009), where they describe the particularity of the decision-making process for asset management with the following four characteristics:

1. Addresses decisions in a network, system-wide fashion rather than a project level;
2. Integrates existing individual infrastructure systems and databases in a common interoperable environment;
3. Introduces and incorporates financial and economic performance measures, ideas, and theories and treats the infrastructure management process as a business, which requires efficiency and effectiveness;
4. Models internal and external processes

The decision-making process for infrastructures and facilities is based on reaching outputs and outcomes, and is developed on the basis of diverging requirements from different stakeholders (such as asset owners, local authorities, regulatory bodies and customers) using different decision levels within the organization.

2.8 Decision-Making in Facility Management

Decision-making is an integral part of a facilities manager's role, as they have to continuously process information and make decisions concerning all aspects of the work environment. When making decisions, managers generally concentrate on decisions output (i.e. cost), but such preoccupation with assessing the decision output tends to underplay the role of how decision are taken. It should be acknowledged that the effectiveness of a decision could be determined predominantly by the quality of the decision-making process used to generate it.

Barrett & Baldry (2003), described that decision makers tend to:

1. Neglect special decision-making procedures when arriving at a choice. Facility managers often do not use a systematic procedure to assess the impact of frequent tasks or obligations.
2. Lack information about the merits and consequences of alternatives. In matters of facility planning, facilities managers often fail to consider alternatives, instead, apply predetermined organizational standards without questions.

Barrett & Baldry (2003) also shows that experience demonstrates how being rational is vital for improving managerial decision allowing for all types and considerable benefits to be obtained, including:

- Providing more structure to poorly-structured problems;
- Extending the manager's information-processing ability;
- Providing cues to the manager of the critical factors in the problem, their importance and the relationships between them;
- Breaking out from 'blinkered' frames of mind to view problems from new perspectives.

The Authors stress the fact that oftentimes facilities managers are known to dismiss any rationalization of the decision-making process, instead, frequently maintain that experience alone is sufficient to achieve good decisions. They summarize that such reasoning is a dangerous path due to the possible consequences and financial impacts.

This study evaluates the proposal of a decision model that can be used to support decision-making during all lifecycle stages for facilities. The main concern at this point is to optimize and integrate current facilities to reduce maintenance cost. The model will be a tool available for future use in the daily operations for any type of decision in Schlumberger Wireline and the rest of its products lines.

2.9 Decision-Making models for Facilities

The existing asset management decisions frameworks are relevant when applied to engineering assets, but not fully suitable when related to large assets such as facilities, where current and valuable information and knowledge is not always available.

For the decision types mentioned above, there is no recognition of how outside forces or contextual factors impact decisions. Some important external factors that heavily affect facilities are the economic, socio-economic demographic and technological regimes under which a decision is made.

In this sense, two different methodologies were evaluated to develop decision-making models that allow flexibility, which can be incorporated as a strategic tool to be used in the process of systematically making decisions about facilities.

1. FMAD: Flexible Asset Maintenance Decision-Making Process:

Amadi-Echendu et al. (2012), explains that: “to make a decision efficiently, a user needs to follow an effective process.” Thus, it is possible to use a generic process model that can be applied to all types of asset management decisions. When developing a generic process model, decision makers need to consider that asset management decisions operate over different timescales and involve a wide range of personnel and activities, while also considering that making different types of decisions requires different information.

Amadi-Echendu et al. (2012) presented a generic process model shown as a decision flux-gram, which has been based on NAMS group’s decision process model and the guidelines, specifications and asset management models provided by PAS 55.

This model presented in figure 3 can be explained as follows:

- Step 1: Define project objectives;
- Step 2: Identify potential problems, failures and issues;

- Step 3: Identification of opportunities' nature to determine whether correspondent to an operational decision or strategic decision;
- Step 4: Define the criteria for failure;
- Step 5: Define the options;
- Step 6: Analyse options against multiple criteria;
- Step 7: Review options;
- Step 8: Complete financial analysis;

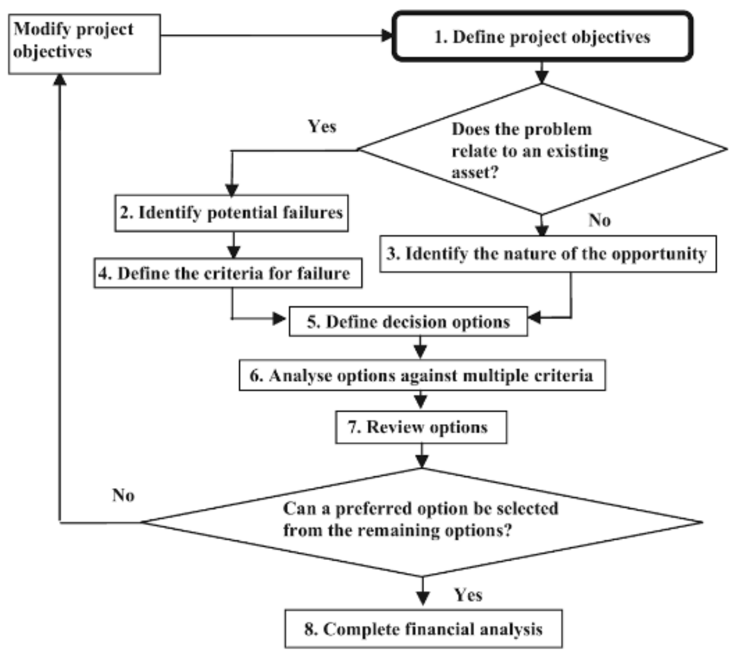

Figure 3: FMAD: Flexible Asset Maintenance Decision-Making Process Based on NAMS (Amadi-Echendu et al., 2012)

The rationale behind this flexible model is that when making asset management decisions, it is always necessary to go through the basic decision-making process, but it is not mandatory to go through all the information, acquisition and generation processes. In this model, the basic decision-making process focuses solely on decision-making activities and has been separated from the decision supporting activities.

2. Basic Model for Decision-Making

Barrett & Baldry (2003) describe that decision-making processes focus around the managerial task of sensing problems and choosing between possible solutions. The decision-making process begins with the exploration of the nature of the problem, followed by the generation and evaluation of possible options, and finishes with the choice of an option. They presented a model, presented in figure 4. The decision model consists of five main stages; each one of them includes several steps that help decision makers in analysing problems.

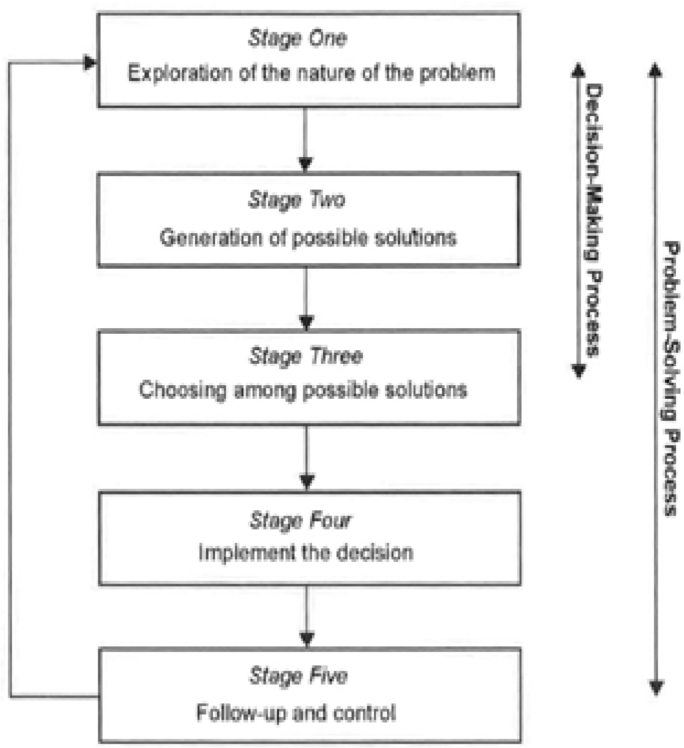

Figure 4: The Basic Decision Model of the problem-solving process (Barrett & Baldry, 2003)

The Basic Decision Model of the problem-solving process can be explained as follows:

Stage one represents the exploration of the nature of the problem – this stage provides a general direction and builds the potential for added value where the benefits of the outcome of the decision-making process exceed the required input of organizational resources. This stage is split into four steps presented within figure 5. The steps break down into, understanding the problem, defining objectives, identifying the type of problem and establishing the decision-making group. In the case that the identified problem is operational, it is possible to jump to stage three to evaluate the solutions. If the problem is strategic, then, the full decision model should be followed.

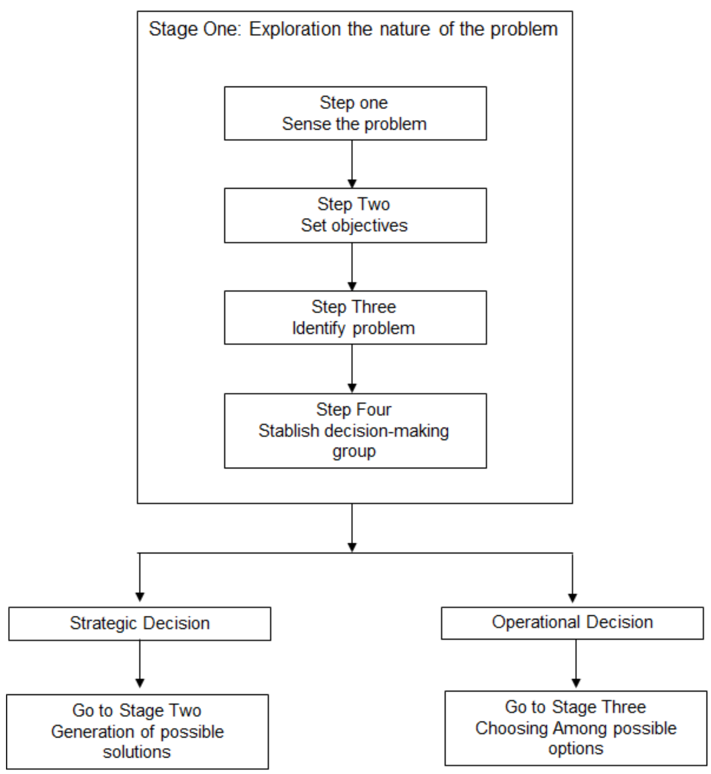

Figure 5: The breakdown of Stage One within the Basic Decision Model (Barrett & Baldry, 2003).

Looking at Stage Two of the model, it consists of the generation of possible solutions. The objective of this stage is to search for information that can be processed into a range of possible solutions. It has two steps as described in figure 6 below:

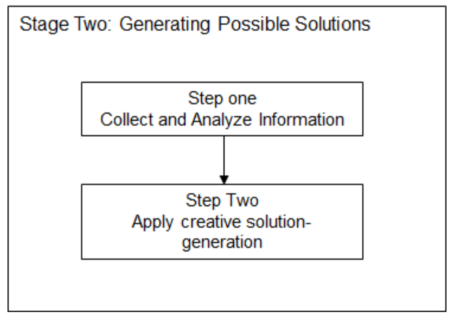

Figure 6: Steps within Stage Two of the Basic Decision Model (Barrett & Baldry, 2003)

Stage three focuses on choosing among possible solutions. The objective of this stage is to evaluate possible solutions against predetermined criteria in order to arrive at an optimal solution. It is the most crucial stage, as the final option should be the output. It is composed of six steps presented below within figure 7.

Stage four and five are implementation and follow up respectively, can be seen in figure 8. For these stages the purpose is to create a plan for the carrying out of activities so the process can be closely monitor until completion. The follow up stage involves the facility manager making sure that what actually happens is what is intended to happen. To enable this, it is necessary to establish a system that allows the collecting and monitoring of information for the different task. Those types of systems are very common in maintenance organizations, but not typically used in facility management – proposing a shared base application system could be considered a positive improvement.

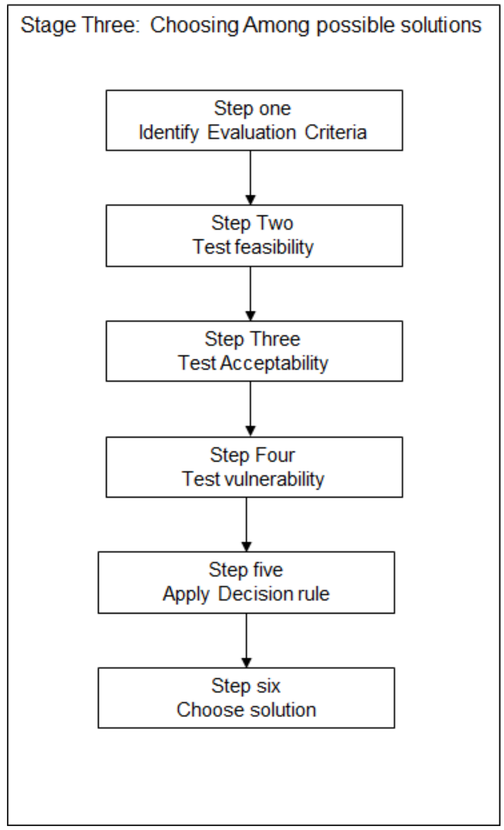

Figure 7: The six steps of on Stage Three of the Basic Decision Model (Barrett and Baldry 2003).

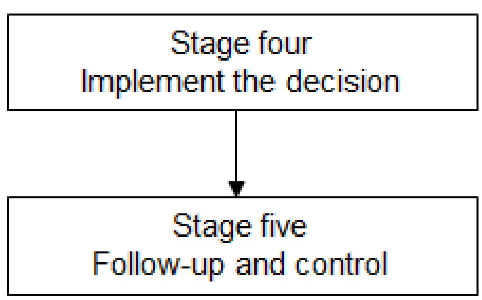

Figure 8: Stages four and five of the Basic Decision Model (Barrett and Baldry 2003

For the purpose of this study, the Decision-Making Process, consisting of stages 1, 2 and 3, will be focused on and used to explore the different facilities options for Schlumberger Wireline Venezuela. Stages 4 and 5 will be presented but not delve into results due to time constraints.

2.4 Chapter 2 Summary

This chapter commenced with a review of asset management theory to further explore the details of facility management and decision-making. The literature review identified relevant points related to asset and facility management such as:

- Different authors' definitions related to facility management agree on the fact that facility management itself can be consider a separate discipline that have evolved, and currently have their own rules, standards and requirements.
- Whereas some well-develop decision-making models are available, there is a deficiency of literature organizing frameworks of decisions and decision support material applicable to asset management – specifically to facilities.
- The standards PAS 55 and ISO-55000 are excellent sources of reference for companies starting to create asset management departments in their organizations.

- There is a lack of information on automated systems for facility management, which can help to create databases to support future decisions.
- While risk has been considered when making evaluations, there is a gap in considering stakeholders' involvement when making decisions for facilities. It is important to stress that this category of asset is greatly impacted by government rules and policies compared to others.
- There are many facility management decision models using financial criteria. Most of these seek to minimise cost, but few consider risk and vulnerability.

CHAPTER 3: CASE STUDY

Applying the decision-making model.
Case Study: Schlumberger Wireline Facilities in Venezuela.

This chapter describes the thesis case study. The decision-making model researched and explained in the last chapter is applied following the different steps that constitute each of the five stages. First, a review of the company will provide a sense of its environment and current situation in terms of facility management and the reasoning/need for the retirement of the facilities operating for Schlumberger Wireline in Venezuela. Then, the decision-making model presented by Barrett & Baldry (2003) will be applied to the different options presented to meet this need. The chapter concludes by presenting the most appropriate solution based on the systematic approach and weighted evaluation.

3.1 A Brief Overview of Schlumberger Wireline in Venezuela.

Schlumberger is the world's leading provider of technology for reservoir characterization, drilling, production, and processing within the oil and gas industry. Working in more than 85 countries and employing approximately 100,000 people who represent over 140 nationalities, Schlumberger supplies the industry's most comprehensive range of products and services, from exploration to production with a focus on optimize reservoir performance (SLB, 2016).

The company manages its business through 35 GeoMarket regions, which are grouped into six geographic areas: North America, Latin America, Europe & Africa, Russia, the Middle East and Asia. The GeoMarket structure offers customers a single point of contact at the local level for field operations, and brings together geographically focused teams to meet local needs and deliver customized solutions.

Schlumberger is well known for its “services delivery anytime, anywhere” model. Its products and services includes open-hole and cased-hole wireline logging; drilling services; well services (such as cementing, coiled tubing, stimulations and sand control); well completion services (including well testing and artificial lift); interpretation and consulting services; and integrated project management.

In Venezuela, the company has been present since 1929, where its first operation was executed on March 6th in Zulia state. Since 2016, due to the falling oil prices, the internal economic crisis within Venezuela and other business decisions, the country formed its own GeoMarket, named VEN.

Wireline services in Venezuela constitute 30% of the overall revenue in the country for Schlumberger where there are three operational facilities in Barinas, Ciudad Ojeda and Maturin represented on the map below (See figure 9). Schlumberger Wireline Venezuela has been implementing cost control initiatives to battle both the fall in oil prices and the economic crisis in an attempt to regain profitability – within these changes, facility management has been at the top of the priorities due to the high maintenance cost and associated liabilities based on governance rules and policies. One of the proposed solutions is to evaluate the current facilities to optimize and reduce the number, seeking to integrate and create a single distribution centre that can cover a larger area and better maximize available resources.

Figure 9: Location of Schlumberger Wireline Facilities in Venezuela (Google Maps, 2016)

3.2 Wireline Facilities in Venezuela: Current Status and Related Problems.

As discussed earlier in this chapter, to cover the Wireline operation in Venezuela, Schlumberger uses three facilities strategically located in Ciudad Ojeda (Facility A), Barinas (Facility B) and Maturin (Facility C). Each facility represent a solution that will be further explore in the model the determined their applicability and converge to one optimal solution. In this section, the main characteristics of each will be presented to help better understand the problems related to their optimization.

Ciudad Ojeda – Wireline Operational Facility (Facility A):

This facility is located in the west of the country within Zulia State, and has 2,000 square meters of constructed structures. It is a property owned by the company that has four buildings that are dedicated to offices and maintenance areas for tools, trucks, cables, pressure equipment and welding. There are also four storage areas for radioactive material, explosives, chemicals and spare parts. The exact location can be seen in the aerial picture below in figure 10.

The current issues and drawbacks of this operational base are:

- High maintenance cost due to age and extended used;
- Lack of an integrated facility management that can track and facilitate all soft and hard services;
- There is no historical database on expenditures and most assets are used until failure, so there is no real evidence on how much is used to keep the base running;
- Major repairs to electrical circuitry, the radioactive storage area and pipelines have been delayed for years and will be overdue soon.

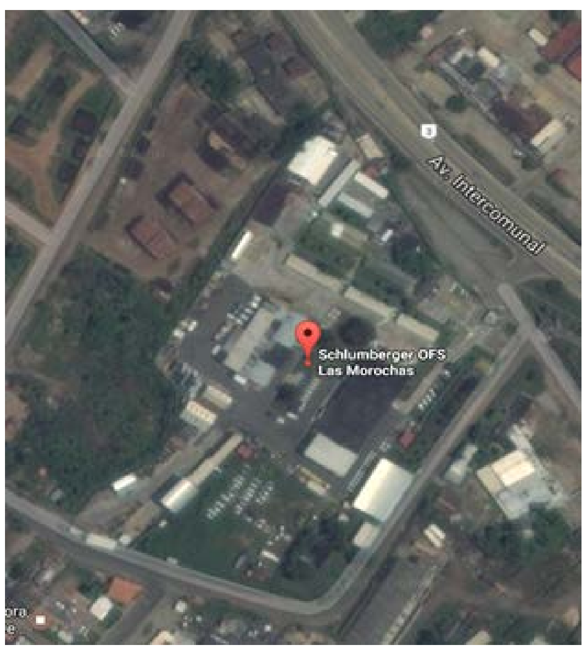

Figure 10: Schlumberger Wireline Facilities in Ciudad Ojeda (Google Maps, 2016)

Barinas – Wireline Operational Facility (Facility B):

This facility is located in the southwest of the country in Barinas State and contains a total of 900 square meters of structures. It is a leased property and has two major buildings dedicated to offices and maintenance areas for tools, trucks and equipment. Major maintenance tasks have to be contracted through third parties. The facility has four storage areas for radioactive material, explosives, chemicals and spare parts. The exact location can be seen in the aerial picture on figure 11.

The current issues and drawbacks of this operational base are:

- Rented facility with valid contract that is renewable in five years;
- Security issues due to the proximity to the borders between Venezuela and Colombia (this area has ongoing issues);
- Transportation infrastructure is poor and not many service providers available in the region;
- No formal facility management – facility assets are used until failure;
- Limited human resource capacity.

Maturin – Wireline Operational Facility (Facility C):

This facility is located in the east side of the country within Monagas State, it contain 10,000 square meters of constructed structures. This owned facility was built as an integrated base where all the different departments coexist and operate. It has several buildings that serve each department. Wireline services use one office building and the general maintenance areas for tools, trucks, pressure equipment, wash bay and shared services. The facility has storages areas for radioactive material, explosives and chemicals. The integrated facility operates with a general store for spare parts, which supplies to all of the service departments within Schlumberger. The exact location can be seen in the aerial picture in figure 12.

The current issues and drawbacks of this operational base are:

- Long driving distances to the fields located in the west and southwest of the country;
- High maintenance cost due to high usage of resources and operational complexity;
- Requires investment to increase storage facilities and to build a cable maintenance area;
- It is a multi-segment facility where space and planning are limited;
- Limited human resource capacity.

Figure 11, Schlumberger Wireline Facilities in Barinas, Google Maps (2016)

Figure 12: Schlumberger Wireline Facilities in Maturin, Google Maps (2016)

3.3 Case Study: Applying a Decision Model to Schlumberger Wireline Facilities in Venezuela.

As described in chapter two, the model presented by Barrett & Baldry (2003) was used as reference to choose among the three options name as: Option 1:Facility A, Option 2: Facility B or Option 3: Facility C (further in the chapter will be indicated as facility A, B, C), for prioritization and optimization of the Schlumberger Wireline facilities. The decision model has five stages, each one constituted by several steps that serves to guide the process until the final output stage can be reached (see section 2.9 in Chapter 2 for reference). The model was applied to evaluate the options and determine which base should be kept operating as a single facility to cover the wireline services within the territory.

3.3.1 Stage One: Exploration of the Nature of the Problem.

The objective of this stage is to provide direction and a foundation – reducing the risk of generating an inappropriate solution and/or excessive use of organizational resources.

Step One: Sensing the Problem.

The problem has been identified as an excessive amount of resources compared to the current activity level, which is expected to further decline in the coming years due to oil prices and the general socio-economic situation the country faces.

The excess of facilities is driving down the profitability of the business due to high maintenance cost and expenses generated to keep the facilities running even at the lowest activity level. In this sense, Schlumberger is looking into integrating resources and optimizing the use of common facilities and/or retiring, returning or selling parts of the existing facilities. The model creates a systematic approach to choose among the current facilities, evaluating different aspects to provide a view beyond a cost or financial analysis.

Step Two: Set Objectives.

In order to properly set an objective to guarantee the success of the decision model, a checklist suggested by Barrett & Baldry (2003), was used as reference. The checklist evaluates if the proposed general objective falls into the category of a SMART objective, which means that the objective has to be: Specific, Measurable, Attainable, Relevant and Trackable. Below, table 1 presents the results of the checklist applied to the general objective.

Decision Objective Checklist		
Problem Description: The excess of facilities is driving down the profitability of the business due to high maintenance cost and expenses generated to keep the facilities running even at the lowest activity level. In this sense, company is looking into integrate resources and optimize the use of common facilities and retired, return or sell part of the existing facilities.		
Proposed Objective: Choose among the three Wireline existing facilities, the one that can be used as an integrated centre to cover the services required in the whole country.		
Problem Characteristics	Comments	Validation
Specific - Is the proposed objectives sufficiently clear to avoid ambiguity and uncertainty?	It's concern the optimal evaluation of Facilities A, B, C	Yes
Measurable - Does the proposed objective enabled its performance to be evaluated?	It is possible to evaluate the impact of the solution	Yes
Attainable - Is the proposed objective realistically attainable?	It is possible to cover the level of operations with a single base.	Yes
Relevant - Is the proposed objective consistent and linked to other organizational objective and processes?	The objective is in line with transformation plan and initiatives to regain profitability.	Yes
Trackable - Does the proposed objective enable progress towards its accomplishment to be monitored?	Objective allow to be monitored until completion on stages 4-5 of the decision model.	Yes

Table 1: SMART Objective Checklist, (Galue, 2016)

Step Three: Identify Problem

This step, identifies whether the sensed problem is strategic or operational. In order to determine the type of problem and what the next steps should be, a checklist has been used to weight the problem. This will guide the decision team in how to progress in making a decision. Figure 13 below explains: if the problem is strategic, then the normal sequence of the decision model should be followed. Yet, if the decision is operational, then it is possible to move to stage three as was noted in chapter 2.

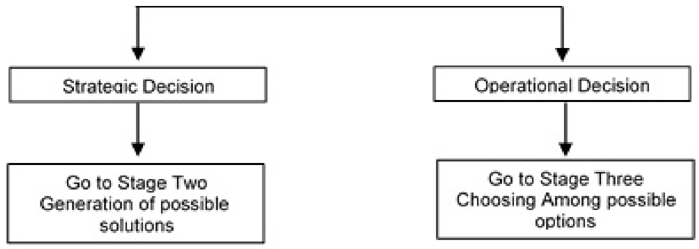

Figure 13: Type of Problem and Subsequent Steps, (Barrett & Baldry, 2003)

The applied checklist is presented below in table 2:

Decision-type diagnostic checklist

Problem description: The excess of facilities is driving down the profitability of the business due to high maintenance cost and expenses generated to keep the facilities running even at the lowest activity level. In this sense, company is looking into integrate resources and optimize the use of common facilities and retired, return or sell part of the existing facilities.

Problem Characteristics	Operational						Strategic
Rarity - How frequently do similar problems occur?	Not rare					x	Very rare
	Notes: Is not a common solution, is being implemented due to current situation						
Radicalism of consequences - How far is the solution of the problem likely to change things within the organization?	Not radical				x		Very radical
	Notes: The effect will have a serious change on the way the services are prepare and run in the coming years						
Seriousness of consequences - How serious would it be for the organization if the chosen solution of the problem went wrong?	Not serious					x	Very serious
	Notes: The evaluation have to include the risk associated with environmental effects and hazardous material						
Diffusion of consequences - How widespread are the effects of the decision likely to be?	Not widespread					x	Very widespread
	Notes: The decision will have impact in different areas						
Endurance of consequences - How long are the effects of any decision likely to remain?	Not long					x	Very long
	Notes: Is expected for a period of at least three to four years, until level of activity increase.						
Percussiveness - How far is the solution of the problem likely to set parameters of subsequent decisions?	Not percussive					x	Very percussive
	Notes: Will stablish the way wireline services will be run in the coming years.						
Number of interest involved - How many parties, both internal and external to the organization are likely to be involved in the solution of the problem?	Few parties					x	Many Parties
	Notes: For the solution different stakeholders are involved because every facility has governance obligations						

Summary: Based on the evaluation, the problem is identified as Strategic

Table 2: Decision Type Diagnostic Checklist, (Galue, 2016)

Step Four: Establish Decision-Making Group

This step helps to establish the optimum decision-making group, with respects to the nature of the problem and the organizational situation. In this sense, the decision-making group was formed with a mixed group of employees from different departments. The group have eight participants from the following areas: two (2) from Maintenance; one (1) from finance; two (2) from the legal department; one (1) safety advisor / radiation safety officer; and two (2) within managerial positions whom know each base and will follow up on the future implementation.

The idea behind this mixed group from different areas within the company is an attempt to create a more objective view while working towards finding the best solution to be implemented.

3.3.2 Stage Two: Generation of Possible Solutions

This stage has two steps – the first, collection and analysis of information related to each option, the second application of methods to create possible optimal scenarios.

Step One: Collect and Analyse Information

Due to the lack of historical data available, a SWOT analysis has been done for each facility in order to identify the Strengths, Weaknesses, Opportunities and Threats of each. Details can be seen in tables 3, 4 and 5 below.

Strengths	Weaknesses
- Strategic location to cover land and offshore operations. - Has a dedicated area for cable maintenance. - Owned facility - Licenses to store explosives and radioactive materials. - Good transportation infrastructure from providers. - Accessibility to all production fields.	- General refurbishment and replacement of the electrical circuitry needed. - High maintenance cost due to age / extended use over lifetime. - Share cost percentage is high due to the occupancy. - No formal facility management.
Opportunities	**Threats**
- Single segment base so the space can be redistributed conveniently. - Creation of a facility management structure. - Implementation of software to control and request facility management requirements. - Possibility to sell the facility.	- The competition has bases operating in the same area, so in the case of closing the facility, the competition can increase its market share.

Table 3: SWOT Analysis for Facility A, (Galue, 2016)

Strengths	Weaknesses
- Accessibility to production fields in the south, border. - Exploration wells in this zone, are likely to continue.	- Complicated located near border, with high security risk. - Transportation infrastructure and service providers not available. - No formal facility management. - Lease facility contract valid for the next 5 years
Opportunities	**Threats**
- The space can be redistributed easily and there are three service departments located in the facility. - Licenses to store explosives and radioactive materials are expired, but can be granted within a short time. - Creation of a facility management structure with a database for keeping track of the maintenance and cost expenditures.	- Competition has connections, which has allowed for the creation of low-priced contracts, allowing them to obtain more work. - Few competitors have facilities in the region, the rest is handle remotely.

Table 4: SWOT Analysis for Facility B, (Galue, 2016)

Strengths	Weaknesses
- Strategic location to cover land and offshore operations. - Owned facility - Licenses to store explosives and radioactive materials are valid. - Good transportation infrastructure from providers. - Accessibility to some of the large production fields.	- Long driving distances to the fields located in the west and southwest of the country. - High maintenance cost due to high usage, and operation complexity. - Facility management in progress, with some friction over changing the way people used to work. - Requires investment to increase storage facilities and to build a cable maintenance area. - Multi-Segment facility; space and planning are limited.
Opportunities	**Threats**
- Create a facility management structure. - Implement systems to control and request facility management activities and expenditures. - Possibility to concentrate all the maintenance and act as a distribution centre.	-The competition has bases operating in the same area, so in the case of closing the facility, the competition can increase its market share.

Table 5: SWOT Analysis for Facility C. (Galue, 2016)

Step Two: Apply Creative Solution Generation Techniques

After several meetings and brainstorming sessions where the decision-making group was actively engaged in creative solutions – the following scenarios were presented:

- Each facility will be evaluated against feasibility, acceptability and vulnerability by the use of checklist with some parameters that will evaluate each point.
- For facility B, which is a leased property, the main solution will be to end the lease early and pay the contract cancellation fee. It will be considered until the end of the process to highlight the work required that would need be taken into consideration upon closure.
- The legal team will look into documentation to properly evaluate the possibilities of selling the properties, and the risk and liabilities associated with that process.
- Final solution will be decided using a table with weighted values from 0 to 5, where the main concerns/issues will be presented and rated. The scale will have 0 being the lowest score and 5 being the highest. This scale and instrument was validated by the subject expert matters in the company, in order to get a numeral valuation for each facility with respect to some specific criteria.
- Each option or facility will be finally evaluated using a decision tree and the weighted criteria from the decision-making group.

3.3.3 Stage Three: Choosing Among Possible Solutions: Facility A, B or C.

The objective of this stage is to evaluate possible solutions against predetermined criteria in order to arrive at an optimal solution. This requires the identification of the evaluation criteria first, followed by the comparison of the alternatives using the selected criteria. This stage has six steps that are presented as follows:

Step One: Identify Evaluation Criteria

This step identifies the principal criteria in which the possible options will be compared. As discussed on the previous stage, this will be decided based on the general consensus among the decision-making group, where the evaluation criteria will consider the feasibility, acceptability and vulnerability of each facility.

The feasibility will measure whether there are sufficient physical, human and financial resources available within the organization to implement the decision successfully. The acceptability will measure the likelihood of choosing each facility – whereas the vulnerability serves to indicate the level of risk associated with each facility.

Step Two: Feasibility Test per Each Facility

Summary of the results:

From the three feasibility tests, facilities A and C have the required skills and resources to apply the required changes allowing them to function as an integrated facility. In terms of financial resources, both facilities require some investment to improve their condition, but only facility C has a positive projection of cash flow due to its proximity to relevant production fields and to contracts that will start in 2017. Facility B, is not feasible due to lack of resources and skills to implement the required structure.

Feasibility test applied to each facility A, B and C, are presented below in tables 6, 7 and 8.

Feasibility Check - Facility A	
Evaluation Criterion	**Response**
Skills Requirements - Does the resources have the skills to implement the solutions?	Yes, the facility have the required level of skills to implement the solutions.
Capacity Requirement - Does the organization have the require capacity in terms of finance, space, human?	Yes, the facility have the required capacity in terms of space and human resources but have limited finance due to low activity and affected cash flow.
Degree of fit - Is the solution compatible with other organizational activities and objectives?	Yes, solution is compatible with organizational activities and transformation objectives.
Summary: The facility have all the resources to apply the changes but it requires some investment to refurbish several areas pending since 2014. Cash flow is limited.	

Table 6: Feasibility check – Facility A. (Galue, 2016)

Feasibility Check - Facility B	
Evaluation Criterion	**Response**
Skills Requirements - Does the resources have the skills to implement the solutions?	No, resources present at the facility does not have the required skills to implement the changes.
Capacity Requirement - Does the organization have the require capacity in terms of finance, space, human?	No, space is available but limited to authorization from landlord. Human resources have to be moved from other locations. Limited cash flow to implement the required changes.
Degree of fit - Is the solution compatible with other organizational activities and objectives?	Some degree of fit, but not completely in line.
Summary: The facility doesn't have all the resources and skills required to apply the changes to the facility.	

Table 7: Feasibility check – Facility B (Galue, 2016)

Feasibility Check - Facility C	
Evaluation Criterion	**Response**
Skills Requirements - Does the resources have the skills to implement the solutions?	Yes, the facility have the required level of skills to implement the solutions.
Capacity Requirement - Does the organization have the require capacity in terms of finance, space, human?	Yes, the facility have the required capacity in terms of space and human resources. For the space have to be discuss with the rest of the product lines. Financially, new contract are coming to close production fields.
Degree of fit - Is the solution compatible with other organizational activities and objectives?	Yes, it is inline with organizational activities and objectives.
Summary: This facility have the required resources and financial possibility. Even though some investment will need to be place to expand some maintenance and storage areas.	

Table 8: Feasibility check – Facility C, (Galue, 2016)

Step Three: Acceptability Test Per Facility.

This test assesses the extent to which the possible solutions satisfy the objective. Below are the results from the acceptability test applied to each facility:

Acceptability Checklist - Facility A	
Evaluation Criterion	**Response**
Operational Impact:	
Technical Specification: Does the proposed solution increase the chance of the service or product which the operation generates being closer to what internal/external clients wants?	Yes, the facility accounted for all the maintenance space, workshop and capacity to generate to execute the services.
Quality: Does the proposed solution reduce the likelihood of errors occurring in the creation of services or products?	The likelihood will continue the same. It is expected that with major changes, the possibility of failures increase until the plan is fully implemented.
Responsiveness: Does the proposed solution shorten the time internal/external clients have to wait for their services or products?	The time will be shorten for the fields located in the west and south-west but will increase for the fields located in the east side of the country.
Dependability: Does the proposed solution give an increase chance of things occurring when they are supposed to occur?	Yes, as a integrated facility, will increase the chance to organize and make activities to happened as planned.
Flexibility: Does the proposed solution increase the flexibility of the operation, either in terms of the range of things which can be achieved or the speed of changing what can be achieved?	Based on the experience from personnel and the installation, yes the change will create a positive impact on the range of things that can be achieve.
Financial Impact: Analysing the financial cost to which an option would commit the organization and the financial benefit which might accrue from the decision	If the company decide to work on this facility, major repairs and extension will have to take place in short time, then an additional expense will be generated. If the company decide to sell the facility will generate some
Summary: Facility A, represent one of the positive options to be transform in an integrated facility. Points that need to be look further are Quality and Financial Impact.	

Table 9: Acceptability check – Facility A, (Galue, 2016)

Acceptability Checklist - Facility B	
Evaluation Criterion	**Response**
Operational Impact:	
Technical Specification: Does the proposed solution increase the chance of the service or product which the operation generates being closer to what internal/external clients wants?	Yes, applying the service standards will provide the same service at each facility.
Quality: Does the proposed solution reduce the likelihood of errors occurring in the creation of services or products?	The likelihood will increase during the adaptation period to a integrated facility.
Responsiveness: Does the proposed solution shorten the time internal/external clients have to wait for their services or products?	No, the location of this facility difficult the shipment of equipment and may increase the delivery times
Dependability: Does the proposed solution give an increase chance of things occurring when they are supposed to occur?	No, the facility doesn't have the required competency and skills for multitasking.
Flexibility: Does the proposed solution increase the flexibility of the operation, either in terms of the range of things which can be achieved or the speed of changing what can be achieved?	No, the adaptation time and adjustments will be bigger compared to the other facilities.
Financial Impact: Analysing the financial cost to which an option would commit the organization and the financial benefit which might accrue from the decision	Financial investment will be high in order to expand different areas to cover the maintenance and storage. In case of returning the facility, there will be a contract cancellation fee, but will be small compared to continue
Summary: Facility B, falls into the category of non-acceptable for becoming an integrated facility.	

Table 10: Acceptability check – Facility B, (Galue, 2016)

Acceptability Checklist - Facility C	
Evaluation Criterion	**Response**
Operational Impact:	
Technical Specification: Does the proposed solution increase the chance of the service or product which the operation generates being closer to what internal/external clients wants?	Yes, applying the service standards will provide the same service at each facility.
Quality: Does the proposed solution reduce the likelihood of errors occurring in the creation of services or products?	The likelihood will continue the same. It is expected that with major changes, the possibility of failures increase until the plan is fully implemented.
Responsiveness: Does the proposed solution shorten the time internal/external clients have to wait for their services or products?	Yes, to the main production fields the answer time will be close due to proximity. With respect to the rest of the country can be manage within an acceptable range of
Dependability: Does the proposed solution give an increase chance of things occurring when they are supposed to occur?	Yes, facility accounts for the infrastructure to fulfil higher level of activity.
Flexibility: Does the proposed solution increase the flexibility of the operation, either in terms of the range of things which can be achieved or the speed of changing what can be achieved?	Friction for personnel will be the main barrier, but facility has additional resources that can help on the adaptation process.
Financial Impact: Analysing the financial cost to which an option would commit the organization and the financial benefit which might accrue from the decision	Major repairs and expansion will have a financial impact in the short term. In case facility is passed to other product lines, company will not have any additional payment.
Summary: Facility C, have the necessary resources and skills to adapt to the proposed service strategy. The main friction will come from personnel as historically there are issues with union representatives. In financial terms, the required expansion can be forecasted and capitalized during the coming year.	

Table 11: Acceptability check – Facility C, (Galue, 2016)

Summary of the results:

From the test it can be seen that Facility C fulfils the criteria for acceptability. Some issues might be encountered due to friction based on historic issues related to worker unions. Facility A also resulted in a positive solution, but financially it will require some refurbish work, which has already been delayed for the past two years. Facility B, will be discarded from the results.

Step Four: Vulnerability Test per Facility

This step assesses the level of risk associated with each possible solution. Five elements will be considered during the test. They are: safety, licenses and permits, personnel security, environment and risk. Below are the results from the vulnerability test:

Vulnerability Checklist - Facility A	
Evaluation Criterion	**Response**
Safety - Does the solution comply with safety standards required for daily operations?	Yes, Facility comply with safety standards required for company and country.
Licenses - Does the solution consider different state licenses required for operation?	Yes, licenses and permits are valid.
Personnel Security - Is the facility located in areas known as high risk for personnel security?	No, the risk for personnel security is low.
Environment - Does the solution consider the compliance in terms of environmental work required?	Yes, environmental permits in compliance.
Risk - Does the solution follows under ALARA considerations if becoming an integrated centre? (ALARA = As low as reasonable achievable)	Level of risk is Medium, considering distance to relevant production and where the biggest work volume will be located.
Summary: Facility represent a medium risk for the organization.	

Table 12: Vulnerability Checklist – Facility A, (Galue, 2016)

Vulnerability Checklist - Facility B	
Evaluation Criterion	**Response**
Safety - Does the solution comply with safety standards required for daily operations?	Yes, facility comply with required standards
Licenses - Does the solution consider different state licenses required for operation?	No, hazardous material licenses are expired but can be obtain in reasonable time.
Personnel Security - Is the facility located in areas known as high risk for personnel security?	Yes, the risk for personnel security is high due to proximity with borders.
Environment - Does the solution consider the compliance in terms of environmental work required?	Yes, environmental permits in compliance.
Risk - Does the solution follow under ALARA principle? (ALARA = As low as reasonable achievable)	The risk for the location is High, based on distance and personnel security risk.
Summary: Facility represent a high risk for the organization	

Table 13: Vulnerability Checklist – Facility B, (Galue, 2016)

Vulnerability Checklist - Facility C	
Evaluation Criterion	**Response**
Safety - Does the solution comply with safety standards required for daily operations?	Yes, facility comply with required safety standards.
Licenses - Does the solution consider different state licenses required for operation?	Yes, licenses and permits are valid.
Personnel Security - Is the facility located in areas known as high risk for personnel security?	No, the site risk is medium to risk due to increment of robbery situations
Environment - Does the solution consider the compliance in terms of environmental work required?	Yes, environmental permits in compliance.
Risk - Does the solution follow under ALARA principle? (ALARA = As low as reasonable achievable)	Level of risk is medium due to increment of robbery and personnel security incidents.
Summary: The level of risk is medium, considering the recent crime statistics on the city, this risk can be lowered taking more severe safety rules at facilities.	

Table 14: Vulnerability Checklist – Facility C, (Galue, 2016)

Summary of results from the vulnerability test:

Analysing the vulnerability evaluations, the results showed that Facilities A and C represent a medium risk in different aspects. In the case of Facility A, the risk stems from the location, as there is a great distance to major production fields where future work will be focused. Meanwhile, for facility C, the risk stems from recent crimes in the surrounding areas. This risk level can be reduced by installing better security measures such as cameras, alarms, and protection fences. For facility B, the risk is high mainly due to its proximity to borders and the presence of paramilitary agents.

Step Five: Applying Decision Rule

The aim of this step is to work through the decision rule to arrive at a solution. To achieve this, two alternative tools will be used in order to determine the optimal solution. The first tool will be a decision tree, which will discriminate the three main criteria: feasibility, acceptability and vulnerability. From implementing this tool an optimal alternative will be drawn. The decision tree that has been used can be seen below in figure 14:

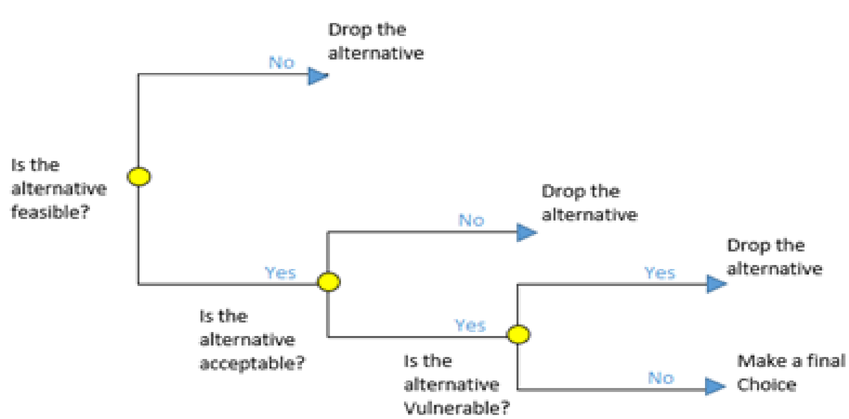

Figure 14: Decision Tree (Galue, 2016)

Working through the decision tree, Facility B is dropped as it represents an option that is neither feasible nor acceptable. For the two remaining options, Facility A and C, both are feasible and acceptable, but only Facility C offers a path towards reducing vulnerability and potential risk from a medium level to low level. In the case of Facility A, even though it has all the adequate resources and skills, the distance to the main production fields presents major barriers.

The second tool that has been used comes from the weighted criteria of different areas that are relevant for the operation of each facility, which was established during the decision-making group's brainstorming sessions. A table has been created to list and compare the three options. After the brainstorming sessions and having collected all the necessary information, the decision-making group as a team will evaluate the criteria and come to a final decision. The result can be seen in table 15.

Evaluation Criteria	Facility A						Facility B						Facility C					
	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Feasibility						X			X									X
Acceptability						X			X									X
Vulnerability - Risk				X				X									X	
Safety Standards					X						X							X
Environmental control						X						X						X
Financial Impact					X					X							X	
Transportation infrastructure						X			X									X
Construction					X						X						X	
Licenses - Permits						X				X								X
Repair - Refurbishing					X					X							X	
Total	44						29						46					

Table 15: Weighted Evaluation from Decision-Making Group (Galue, 2016)

Step Six: Choosing a Solution

After all the information was collected, it was then possible to recognize the optimal solution for the facilities optimization for Schlumberger Wireline Venezuela. The option that met the most criteria is Facility C. The other two facilities will be evaluated further to create a plan for ending operations and returning/selling properties.

3.3.4 Stage Four: Implement Decision

The implementation stage involves the required planning and carrying out of activities so that the chosen solution actually solves the problem. As the solution requires time to be implemented, this study will only present the steps that the decision-making group has undertaken up until December 2016 with the final implementation taking place during June 2017.

It is relevant to describe that the solution will not only involve transforming Facility C into an integrated centre to cover all wireline services in Venezuela for Schlumberger, but it will also extend to other solutions to be implemented for the other facilities. Based on the brainstorming sessions and the evaluations made through the decision-making model, Facility B will be decommissioned and returned to the landlord. Meanwhile, Facility A will also be decommissioned and prepared to be sold to local suppliers in order to recover part of the investment – that income will then be used towards the expansions required for Facility C.

Table 16 shows the list of tasks required to implement the solution presented within the desired timeframe. Each colour represents a different team that will be working towards managing the objectives for the different tasks.

Task	2016	2017					
	Dec	Jan	Feb	Mar	Apr	May	Jun
Decommissioning of Facility B (Barinas Operational Base)							
Moving all assets to Facility C							
Decommissioning of Facility A (Ciudad Ojeda Operational Base)							
Moving all assets to Facility C							
Selling and delivering facility							
Conditioning Facility C to receive all assets for other bases							
Expansion plan for Facility C							
Implementation of Facility Management Support Structure							
Implementation of iBASE - Share Base Support Software							

Table 16: Implementation Plan (Galue, 2016)

3.3.5 Stage Five: Follow Up and Control

This stage involves the facility managers making sure the plan is actually followed. In this sense, it is critical that the facility management can supports structure is properly implemented together with the shared support application in order to control and collect all the information from the different tasks and services. Below is the iBase application with what is intended to work as a facility management structure.

Figure 15: iBASE application (Galue, 2016)

3.4 Chapter 3 Summary

This chapter delved into Schlumberger's background and the details of the current situation for the facilities operating in Venezuela to cover wireline services. The three current facilities that are in use were presented, as well as the reasoning for the need to optimize the current arrangement. SWOT analysis were employed to highlight the pros and cons for each facility, while the model presented by Barrett & Baldry (2003) was used as a reference to build a decision-making model to systematically approach problems related to Schlumberger Wireline Venezuela. A decision-making group was established to properly apply the model and evaluate the options of leaving one of the three facilities operating and covering the services for the entire territory.

Upon the application of the model, the results presented Facility C (the integrated facility in Maturin) as the most optimal option to become the main facility for wireline services in Venezuela.

CHAPTER 4: DISCUSSION AND CONCLUSION

The main purpose of this chapter is to present a discussion of the results that will guide the generation of conclusions. This discussion is related to the identification of whether the scope of work and defined objectives were met during the execution of the research to further delve into the presentation of findings, learning areas and challenges encountered. The chapter end with conclusions which will aim to sum up the work.

4.1 Discussion of the work with the thesis.

4.1.1 Scope of work and objectives.

The scope of this thesis involved a main objective and several sub objectives related to three main subjects, namely asset management, decision-making and facility management. By first performing an analysis of asset management theory and current practices on how decisions related to assets are made, it has been possible to identify some important areas that need attention and focus, specifically in services companies like Schlumberger Wireline.

Even though, facilities are part of the asset classification have been handled apart from other asset and maintenance functions. This practice have established a gap between engineering asset and long-term assets, and gets even bigger when it comes to decision-making. For engineering assets, industry have evolved together with maintenance implementing standards that required data to manage decisions. Meanwhile for facilities, theory and practices are behind and still rely in manager’s capability to handle operational and strategic decisions.

In this sense, as demanded on the objectives, it is required to develop a systematic decision-making model that can be used as reference for taking decisions when facilities are involved.

As any asset, facilities also has a lifecycle, which can be reach once the cost for safely maintain operations is higher than the profits, then we need to evaluate options on how optimize the assets to regain profitability levels and cash flow. This kind of decisions for facilities involved internal and external stakeholders and can’t only be rely on financial cost but include several aspect the reduce organization's liabilities.

Based on above statements it is relevant to use a multi-criteria, flexible model that can implement and evaluate from a wide perspective. From the above it is authors’ opinion that the define scope of work and the objectives of this thesis have been fulfilled

4.1.2 Main Findings.

Based on the information gathered during literature review and application of the decision model during the execution of the case study, the following finding were discovered:

- Based on literature review and field work (observation on the way different facilities are managed), there seems to be a misconception on facility management responsibilities in services companies, as the focus is placed on maintenance and reactive measures. There is a tendency of running asset until failure before repairing.

- As explained by Barret & Baldry (2003), it was perceive that facility managers do not use a systematic procedure to assess the impact of frequent tasks or obligations and have lack of information about the merits and consequences of alternatives when assessing problems.
- Decision-Making process in facility managers have been known to dismiss any rationalization of the decision-making process. Instead, managers frequently maintain that experience alone is sufficient to achieve good decisions.
- Flexible decision-models, are suitable to be applied in decisions where internal and external stakeholders is significant and models have to be adjusted to problems' context and changing decision criteria.
- For oilfield service companies, in particular to Schlumberger Wireline in Venezuela, there is a gap between particular asset management standards (applied by each service company) and international standards such as PAS-55 or ISO-55000. Both comply and covered the same principles but there is still some differences among them, especially when concerned on decision-making making and asset utilization.
- When relating to facility management there is a need to implement systems or applications that served as databases and help controlling the activities and keep a record of work and expenditures that can be

used as input data for decision-making in the future. Currently this is an area for improvement as the majority of the facilities for Schlumberger Wireline in Venezuela still using indirect ways of communication to request services.

- The case study of Schlumberger Wireline in Venezuela, revealed several areas where improvements in facility management can be made, because several of these related to the way organization is structured and operated. It however also revealed that the company already is addressing some of this challenges by changing the way decision-making was applied. This prove that the organization is transforming the way they used to work to accommodate to an optimized utilization of their assets. The focus is placed into continuous improvement of safety, quality and efficiency.

4.1.3 Obtained Learning

The work with this thesis have provided the author and overall learning and better understanding of the subject asset management and its related elements. From the different asset, the focus was placed on facility management, which can be classified as a separated discipline by itself, because in some countries, services industries have evolved at the same pace of engineering assets, but is not the case for the oilfield service companies, where it is an area for future development.

Decision-making skills were also reinforced understanding how different authors suggest frameworks to be used when solving problems. The majority of this frameworks or models are based on standards either PAS-55 or ISO-55000. It was understood that decision-making when related to facilities are challenging due to lack of cases, information and models available that can be applied.

During the study of possibilities two main models were founds, taking the best of each one to develop a model that is flexible enough to accommodate any type of decision in facility management. Through the study different books and papers, the author have obtain a higher degree of knowledge and understanding on the topics mentioned above, as well as on the operation management skills when making decisions and working with teams through transition periods.

4.1.4 Encountered Challenges

During the execution of the thesis several challenges were encountered at different stages of the research. The mention few of them:

- Available literature for facility management: Is was found a wide selection of books and papers related to facility management as a discipline and related to coordination of services and maintenance, but only few that consider the importance of the decision-making as part of the facility manager responsibilities. In this sense, Barret & Baldry (2003), was used as the main reference in this concern.
- Time constraint: the study itself was limited on time, in this case until December 2016, in respect to this, it was not possible to measure the

implementation of the solution given by the application on the model to optimize the facilities for Schlumberger Wireline in Venezuela.

- Scope of work and Thesis: due to constant changing environment in Schlumberger and social – economic situation in Venezuela, research suffer modification from the initial stage until the final result, even passing through the possibility of cancelling the study per se. After all the changes, it was possible to adjust to the current objectives and find an application that could be use regardless the situation changes.
- Resistance to change: this is related to the people initially involved in the process and the friction created to change the way they were working for several years, as they initially react negatively to the application of the model. Upon explaining and proper involvement the decision-making group was finally engaged in the work and committed to the results.

4.2 Conclusions

This thesis delve into a literature review on the subject of decision-making applied to asset management, specifically to facilities. A contextualization of this theory have been made by developing a flexible model that can be applied to any decision in facility management. The case study proposed to the implementation of this model, was the optimization of Schlumberger wireline facilities in Venezuela to create an integrated operations base and present other solutions to the other facilities.

It can be concluded that selecting a suitable methodology to support decision-making in facility management is dependent of the context and nature of the problems, the content, organization's objectives and stakeholder involvement. In this thesis, it was shown that decision-making process for facilities can be studied by applying a systematic multi-criteria method. The proposed model combine basic decision methods such a structured common sense and more advance tools such as weighted parameters and decision-trees. The developed model managed and answered the sub-objectives presented in this research:

- Discuss the current situation and related problems;
- Define and discuss possible options/solutions;
- Establish a model to discriminate among possible options;
- Define decision-making criteria and assess how the possible options;
- Use the model to find the best alternative for asset optimization.

The developed model main characteristic is the flexibility that allows to be used for different types of problems, whether are operations or strategic. The flexibility level was achieved by making the decision-making process to focuses solely on decision-making activities, separated from the decision supporting activities and information gathering tasks.

Applying flexible methods to analyse the facilities decision process allows for the characterization of the decision-making process as a system. The flexible method allows the development of an analytical framework that outlines the system demarcation by defining a boundary of the decision process and the elements that are relevant. By defining the boundaries of the decision-making process, the factors that are part of the decision-making system were separated and evaluated into a determined criteria, that is consider to affect the internal and external stakeholders.

From the review of decision-making theory that has been applied to asset management, it has been noted that depending on the author and the needs, the way in which a manager reaches their decisions can change. Most companies already have a policy for asset management, which includes a framework for decision-making. Those frameworks/models work well with engineering assets, due to the different approaches and previous knowledge, since asset management has oftentimes been purely related to maintenance activities.

When evaluating decisions regarding long-term assets such as facilities, the challenge is more difficult. There is little to non-historical data to support decisions, and based on the managers will, they tend to use financial influences or take a subjective approach relying on experience, which can lead to undesired results.

This study adds to the scientific knowledge gap by combining theoretical insights from both asset management theory and facility management. Even though facilities are included as one of the asset classes identified by the standard PAS-55, it being handle separately and differently to the rest of the assets, same applies to the decision-making processes. With this approach I was able to explore and analyse decision-making for asset management as a research domain. By building upon existing decision-making frameworks for asset management and facility management perspectives, and by developing the decision-making model, this study adds to the scientific field, especially looking into standardize how decisions are made when related to facilities.

The need for improved information and processes handling in facility management at Schlumberger in Venezuela have been identified as a major need, decision-making prior to this study was solely based on assessor previous experience but no on data or stakeholders involvement. The information gathering and processes control may be enabled by the implementation of an application such as iBase, already working in other countries, this will close the knowledge gap, and provide support data to systematically handle and support decision-making.

CHAPTER 5: RECOMMENDATIONS

For further research on this topic, is relevant to look at the time constraint in order to avoid limiting the scope of work, and run the solution until final implementation and follow up.

This research showed the interrelation between the decision-making processes and an asset management for facilities. Demonstrating this interrelation opens an opportunity for further research that focuses on characterizing and understanding the importance to act over this interrelation in order to reach the desired goals.

A concept that was mentioned by most of the participants, but was out of the scope of this research, was the effect of the culture on the outcomes of asset management, this can be suggested as a future research. Most of the participants have recognized that asset management is not only a standardized approach to manage the asset, but it is also a way of thinking about the assets. From the experience gained during this research, was learned that alignment between the participants was felt when discussing common topics that cannot be characterized but were part of the organization's standards and transformation initiatives. Examples are sustainability, innovation, integrated facility management, multi skilling to mention some.

Likewise, another subject for future research is managing the people through changes. Facility managers should be aware that the higher a person’s level of resistance to change, the lower their level of motivation and subsequent job performance tends to be. This is relevant when implemented changes like integration or merging facilities because of the life changes and impacts that create in the workers.

Further research could also considered to evaluate and characterize the difference between particular asset management process used in service companies and the international standard ISO-55000.

In the same perspective further research can be proposed on the following subjects:

- Continues development and improvement of the multi-criteria decision-model for facility management.
- Further research into innovate systems for facility management
- Use of an IRGC framework when deciding among critical asset where the involvement of external stakeholders is high.

5.1 Closing Comments

Facility Management can be considered a discipline of study with its own procedures, and rules; and it has started to develop its own theories and principles which are reflected in the number of books, articles and courses that have started taking place.

With no previous experience in the field of facility management, the details of my evaluation were limited to the understanding obtained during the research process. Taking apart these difficulties, the research process allowed me to explore asset management as a discipline different from the approach followed by Schlumberger.

I hope that this research contributes to the importance of asset management as a resource to confront the future challenges in the oilfield business and can serve as reference for future work on services industries.

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