

**TITLE:** Knowledge Management applied to refineries maintenance: a new approach

**AUTHOR:** Manuel Hurtado Hernández

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### **ABSTRACT**

Maintenance is an activity that assures competitiveness and makes possible that all the actives of the company achieve their expected function. Maintenance is very important due to its connection to many other aspects of the organization like production, amortization or energy consumption.

Nowadays, Oil & Gas companies need to improve refineries maintenance competitiveness to face increasing competition, costs and management models that are too traditional in this field.

Refineries maintenance activities are strongly based in self-experience, maintenance professionals' knowledge is mainly Tacit Knowledge.

Unfortunately, Tacit Knowledge, based on experience and difficult to transmit due to its complexity, does not turn into Explicit Knowledge, independent from the individual because is based on documents, software or any other type of technology.

In general, we can say that the more experienced employees know better about the maintenance of the system and this experience is gained through the years. If the employee leaves the company, this know-how leaves with him.

The loss or damage of Tacit Knowledge leads directly to economic losses.

The new method of Knowledge Management proposed in this paper transforms Tacit Knowledge into Explicit Knowledge to make it available to all the members of the organization leading to an improvement in time, money and energy efficiency in the maintenance activities of the company.

First, we identify all the valuable Tacit Knowledge available in the organization. Secondly, we transform this Tacit Knowledge into Explicit Knowledge: the invisible becomes visible. Finally, we make it available to everybody in the organization using the possibilities of the new Digital era.

As a result, Knowledge Management becomes a competitive advantage.

## Knowledge Management applied to refineries maintenance: A new approach

### Introduction to industrial maintenance: The importance of competitive maintenance.

Maintenance is an activity that assures companies competitiveness and makes possible that all the actives achieve their expected function.

We can classify industrial maintenance in three big groups:

#### *Corrective Maintenance*

It takes place after the failure or threat. It only acts after the problem has already happened.

#### *Preventive Maintenance*

Before the threat or failure. It takes place under control circumstances and without a prior problem in the system. It is based on experience and usually the manufacturer gives the instructions to apply it.

#### *Predictive Maintenance*

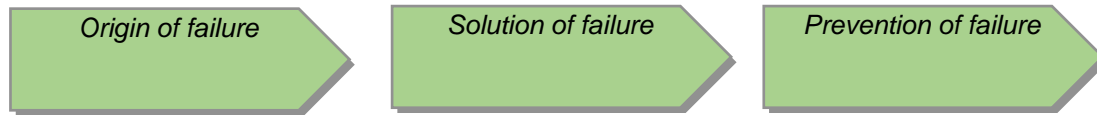
Based on measures and control of parameters and operative conditions of an equipment or installation. There are pre-alert values because the objective of this maintenance is to preview, with some tolerance margin, when is the equipment going to fail.

Threats can be classified in many different ways, for example: progressive or sudden, dependent or independent, critical or minor.

Threats can cause a drop in dependability so we can make a difference between a fault that is just a defect in a system, an error that is a deviation between the desire behaviour of the system and the actual one and a failure that is when the system is not operating within the expected specification.

When there are very few failures in a system, it is difficult to set a real failure probability based on statistic observation, so it is usual to split the system in elements. Elements of a system are more likely to fail than the entire system.

Once we detect a failure in the system or one of its elements, there are three classic problems:



This are the three elements of the failure chain, and they are observable through some specific symptoms.

Maintenance needs to give an answer to this three problems.

But, why is maintenance so important? Maintenance is very connected to other aspects of the organization like production (stops and reliability), amortization (it improves dependability), staff (that usually needs a lot of experience and qualification) and energy consumption (it is necessary to have a control and monitoring of the energy consumption of the equipment to assure energy efficiency).

To sum up, it is all about availability at minimum cost.

All in all, improve maintenance competitiveness is necessary to face increasing competition, costs and management models that are too traditional in this field.

### The current situation of refineries maintenance: The problem of Tacit Knowledge.

If we use the Deming circle, an iterative four-step management method (Plan, Do, Check, Act) we can say that maintenance activities are intensive in DO but they do not pay attention to the rest of actions.

Refineries maintenance workers knowledge is strongly based in self-experience, it is Tacit Knowledge.

But, what is Tacit Knowledge? In Knowledge Management there are two main types of knowledge: Explicit and Tacit.

- **Explicit Knowledge:** It is transmitted in a formal and systematic way. It is independent from the individual because it is based on documents, images, software or any other type of technology.

It is a knowledge that can be easily used and located inside the organization, it is not lost with staff rotation, and it is easy to transmit and storage. On the other hand, it is necessary to invest in information technologies, resources for its implementation and there is a risk of copy from other organizations.

- **Tacit Knowledge:** It is the personal knowledge, difficult to transmit due to its complexity and because it is inside the mind of the person. It is based on experience, and know-how and it is shared directly through personal interactions.

It is used unconsciously and it is very pragmatic, experimental and situational. Unfortunately, it is very difficult to transmit and storage and there is a big loss of knowledge with staff rotation.

Maintenance techniques have lacks when it comes to knowledge transmission. The main one is that Tacit Knowledge is not turn into Explicit Knowledge.

The high level of Tacit Knowledge of operators and wrong Knowledge Management have several consequences:

*Steep learning curve of new operators*

It takes a lot of time until a new operator becomes fully operative. Furthermore, experienced workers need to use part of their time to teach the newcomers. Know-how is concentrated in the people with more experience.

*Lack of information about certain threats*

There is a lot of information that is not complete, badly documented or directly not registered. There is a lack of information about critical failures, emergencies or non-cyclical threats. This knowledge is critical and may have high economic impact.

*Dependence on employees' Tacit Knowledge*

The company is prisoner of this knowledge and they lose it if the employee leaves the company. This loss of information generates economic and operative problems.

*Disorganisation of current information*

Explicit knowledge about some equipment and systems is badly organised or not updated. Manuals, methods and procedures are obsolete.

*Big amount of useless information*

Information is so huge and broad that maintenance staff have problems to find the precise information they need. This increases reaction times.

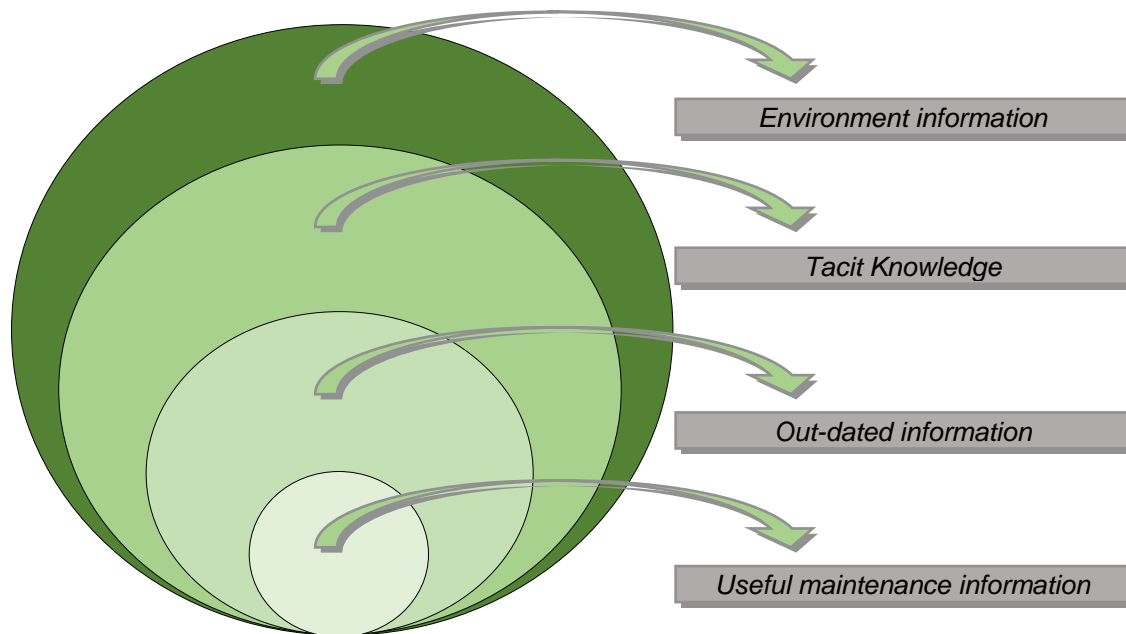
*Scarcity in the learning methods*

There are problems with the acquisition of useful and applied knowledge.

In general, we can say that the more experienced employees know better about the maintenance of the system and this experience is gained through the years: know-how.

There is some reluctance to share knowledge. Employees have the feeling that this is what makes them valuable for the company so if they share it, they will be no longer indispensable.

The loss or damage of Tacit Knowledge leads directly to economic losses.



*Figure 1. Distribution of Knowledge in refineries maintenance*

### Knowledge Management applied to maintenance activities as a competitive advantage

Knowledge Management captures all the intangible information that may affect the organization. Knowledge Management is about the structures, systems and actions consciously designed to manage all the knowledge and abilities of the company.

There are several goals and benefits to achieve with the proper Knowledge Management:

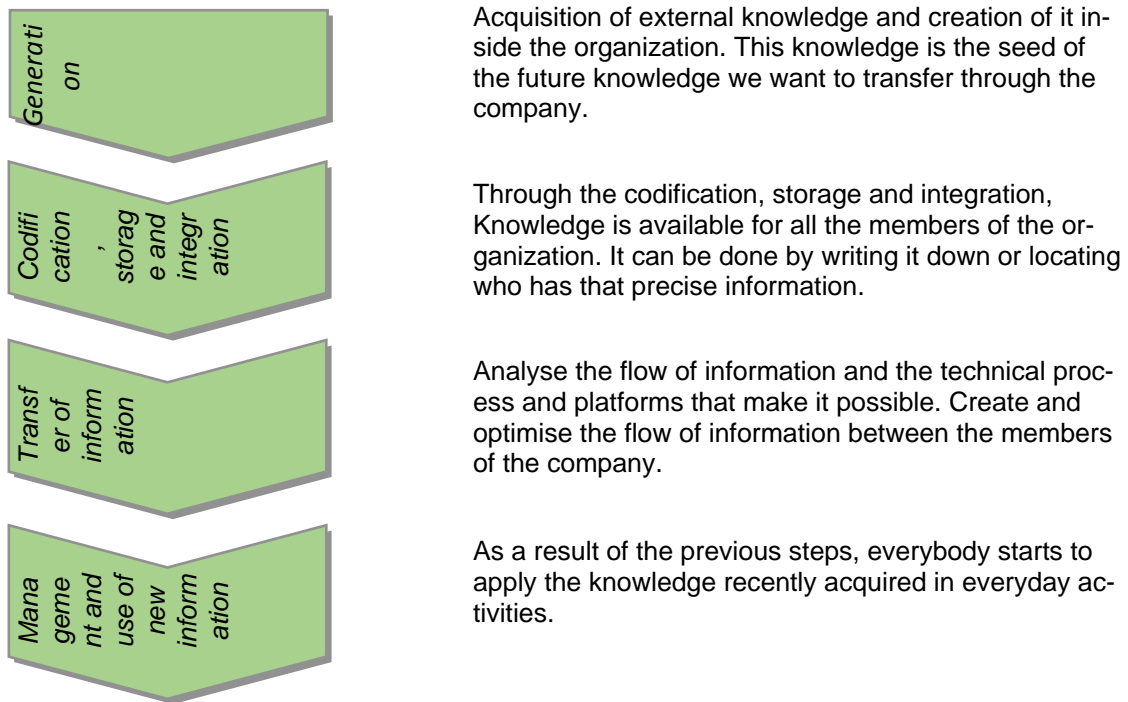
- Study and analyse the knowledge flow, especially Tacit Knowledge. Design knowledge maps that directly help maintenance operations.
- Improve the time between the incorporation of a new employee and the moment he or she becomes fully operative. Create new methods of continuous learning, expansion of skills through learning and increasing knowledge for both, new and experienced employees.
- Improve reaction time against failures and threats. Link the operative techniques of maintenance with the distribution of knowledge.
- Improve energy efficiency of the refinery equipment with a better maintenance of all the elements of the system.

The new method of Knowledge Management proposed transforms Tacit Knowledge to Explicit Knowledge to make it available to all the members of the organization leading to an improvement in time, money and energy efficiency in the maintenance activities of the company.

As a result, Knowledge Management becomes a competitive advantage.

## Steps to implementing Knowledge Management

Knowledge Management can be seen as a process with four steps:



Generation and transfer of information are the steps that involve more Tacit Knowledge. During the second step, codification, storage and integration, Tacit Knowledge is transformed into Explicit Knowledge.

This methodology is supported by three main pillars: people, environment and technology.

## Knowledge Management applied to refineries maintenance in practice

The implementation of Knowledge Management in a refinery must be seen as a project that can be divided in three different phases:

1. Identification of valuable Tacit Knowledge available in the organization: Change Management
2. Transformation of Tacit Knowledge into Explicit Knowledge: The invisible becomes visible
3. Expansion and use of the new sources of information: Digital support

### Phase 1: Identification of valuable Tacit Knowledge available in the organization: Change Management

The objective of this phase is to have an updated and valuable analysis of the current situation of maintenance activities in the system.

Firstly, we must clearly identify the process and duties of maintenance department.

Secondly, we will estimate and define the current state of Knowledge Management.

Question lists and surveys are distributed to all the members of the maintenance organization in order to analyse how they are connected, the methods of communication between them and their daily activities. It will work as a pre-diagnosis of the situation.

Thirdly, there are different meetings with the members of the maintenance organization at all levels to make them take part of this change and identify possible resistance to change. Change management becomes very important at this point.

The methodology of the investigation to identify the feeling and the current situation of Knowledge Management in the organization must consider this tactics:

- **Come to an understanding with the senior members of the maintenance department** about the questions to include in the surveys and question lists. This will make them feel more involved in this change.
- **Deeply analyse the duties and processes of the maintenance department** through meetings between managers and senior staff.
- **Create discuss groups** with the heads of the different sections of the maintenance department in order to get their opinion and possible ideas.
- **Personal interview with the operative maintenance staff.** Study of their internal relations and the characteristics of the information used daily.
- **Analysis of the current documentation, manuals and procedures.** Detection of obsolete or out-dated documentation.

- **Survey between all the staff** to quantify their perception about how much of their own knowledge (Tacit Knowledge) and documented knowledge (Explicit Knowledge) they use every day.

We can find some barriers during the implementation of the first phase such as lack of time, resistance to change, cultural barriers as Tacit Knowledge is widely spread within the organization or lack of involvement from the employees.

To fight against this problems, we must be sure that everybody knows about the benefits of the project and raise awareness of the necessity of implementing Knowledge Management.

## Phase 2: Transformation of Tacit Knowledge into Explicit Knowledge: The invisible becomes visible

The objective of the second phase is to reduce the Tacit Knowledge of the organization and increase the Explicit Knowledge making it more useful and comprehensible for everybody.

All the information will be captured in new documents that will receive the name of Maintenance Cases (MC) and will have the following characteristics:

- Design as a book with summarised knowledge, accurate and flexible.
- They will collect technical data, operative and experiences about a certain element of the system, there will be a Maintenance Case for every element of the system.
- The document will be different depending on the type of equipment and system. Its configuration and distribution will be based on the space and layout of the plant.

Once all this information is gathered, we will create the Knowledge Map of the organization. A Knowledge Map is a tool for presenting what knowledge resides where and for visualizing the patterns of knowledge flow.

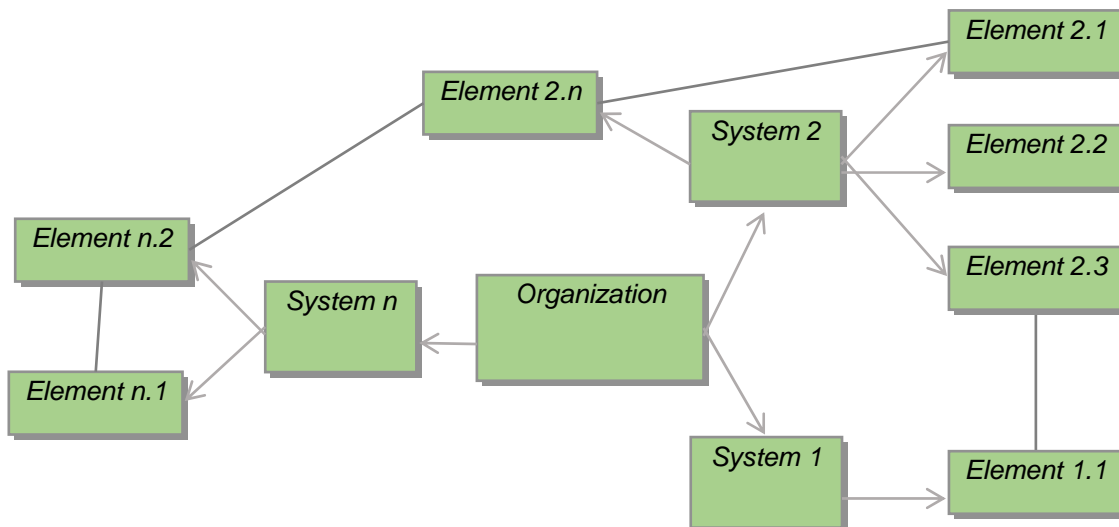
The Knowledge Map will be based on the information of previous tasks and will be structured bottom-up, from the particular to the general.

The core of the Knowledge Map will be the Element, the smaller part of the system we consider in the maintenance activities. Every Element will be analysed according to four strategic characteristics: reliability, operative information, ease of maintenance and energy efficiency.

The Knowledge Map will work as a directory of the knowledge inside the organization. A guide and list of people or documents about all the information related to the proper maintenance of each Element of the system.

The Knowledge Map is not properly the knowledge, it is the reference to the knowledge. The idea is that every member of the organization can easily access to the Map in order to know where all the information about every Element of the system and the connection between them is.





*Figure 2. Elements and their connections through the Knowledge Map*

### Phase 3: Expansion and use of the new sources of information: Digital support

Procedures and documentation about refineries maintenance is usually old-fashioned and out-dated. It is necessary to transform the process of creation and storage of knowledge into a more dynamic one.

The idea is that with the interaction between the individuals, Tacit and Explicit Knowledge are shared and if this relation is fostered we enter a spiral of knowledge that becomes bigger and bigger.

In this phase, a new Knowledge Platform will be implemented. This platform will be adapted to the new digital era and will consist in a new Software System and also an APP to increase mobility.

The knowledge about every Element and the Knowledge Map will be accessible from the Knowledge Platform so every member of the organization can have all the information about any equipment in just a few clicks. As the information is structured in Elements, the management and localization of the desire information will be extremely easy.

Furthermore, there will be the possibility to contribute to the knowledge of every Element, adding information that we may consider useful for other users or colleagues.

In addition, the knowledge about every Element will be rated, so we will have the Knowledge Rating of all the Elements of the systems which will help to detect weaknesses in the system so we can focus to improve the information in the Elements with poor Knowledge Rating.

As the Elements are connected through the Knowledge Map, we will be able to detect areas or groups of Elements with lack of information.

This information, presented as graphs of the situation of knowledge will help to indicate the trends and to focus time and resources in the most vulnerable parts of the system.

## Conclusion

Maintenance is a very important part of everyday activities in Oil and Gas companies. It has a big connection with many other aspects of the organization like production, amortization or energy consumption.

In the current landscape of increasing competition, increasing costs and too traditional management models, Oil and Gas companies need to improve refineries maintenance competitiveness.

As we said before, refineries maintenance is strongly based in Tacit Knowledge, a kind of knowledge difficult to transmit and easy to damage and lose what leads directly to economic losses.

The new method of Knowledge Management proposed in this paper transforms Tacit Knowledge into Explicit Knowledge to make it available to all the members of the organization leading to an improvement in time, money and energy efficiency in the maintenance activities of the company.

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