

A Managerial Challenge: Selecting an appropriate model for implementing the Corrosion Management System, Case Study: National Iranian Gas Company

Ali Massaeli

Corrosion Management System Project Manager
Technical Inspection and Control Department
National Iranian Gas Company
Tehran, IRAN
massaeli@nigc.ir

Abstract

A CMS (Corrosion Management System) is the management system including specific documentation identifying the processes and reengineering procedures affecting the corrosion management which is basically needed for Planning (PLAN), Implementation (DO), monitoring and measurement (CHECK) and defining the corrective action (ACT), also the ability of the organization to manage the threat of harmful corrosion phenomenon for future asset integrity management.

Choosing an appropriate CMS model which is fitted for gas supply chain from basic design and early engineering via installation, commissioning, operation and sweetening process, transmission, and distribution of the natural gas is the main managerial challenge for the stakeholders of this project. (Note that there is no events or standard model for implementation of CMS in such this case)

The purpose of this paper is introducing a methodology for selecting a suitable CMS roadmap.

Keywords

CMS, AIMS, CSF, Deming Cycle, Delphi Method, MCDM

1. INTRODUCTION

According to the NACE IMPACT 2016 report which is studied corrosion phenomena cost in 2013, the global corrosion costs was estimated in 2.5 trillion USD in this year which is equal to 3.4 US GDP (Gross Domestic Product) in year 2013! By means of implementation of suitable corrosion management system, according to the best practices studies it is estimated that amount of 10-25% of the corrosion costs could be saved; which is the amount of 340-875 billion USD per year is taken into the account[1]; What a big deal! As per previous studies by NACE the corrosion phenomena is the primary threat affecting the reliability and life cycle of assets that decline crucial energy sources throughout the worldwide. The estimated annual corrosion-related costs is about 7 billion USD to monitor, repair (and maintenance) of the assets. According to this study the corrosion- related cost of operation and maintenance is estimated up to 80% of this cost [2]. In order to control and manage the corrosion threats (or impact) it should be taken into account the consequences and likelihood of corrosion phenomena occurrences simultaneously. For the purposes of this paper, for selecting appropriate model for CMS implementation in purposed company, the consequence (or impact) of corrosion phenomena is considered as the potential or actual money loss due to corrosion effects (leakages and metal loss) associated by the Health, Safety and Environmental aspects, or asset integrity management system concerns. The first criteria (money loss) could be taken into account as quantifiable value when taking into consideration of direct and indirect costs including (revenue losses, maintenance (repairmen), and clean-up costs, material costs and etc. which is called the Direct Costs). Other perspective of corrosion threat include decline of an asset to the point where it is no longer fit for its intended purpose (e.g., future production losses, Environmental crisis fines such as soil contamination, air pollution, river

and sea contaminations, Taxes are based on international, national and provincial laws which is called as Indirect Costs).

Basically, corrosion impact should be reduced (or mitigated) to a point where the cost of resources (including direct and indirect cost of corrosion phenomena) is balanced against the gained benefits. As the consequences of this approach (financial perspective of corrosion phenomena) is that a financial analysis might illustrate that a technically corrosion mitigation planning and implementation is insufficient regarding total corrosion costs (direct and indirect costs). Regarding to this approach the investment for appropriate CMS is obviously reasonable, but in order to justify this fact, a comparison of the potential corrosion consequences via a Return on Investment (ROI) analysis could be a useful way. As per corporate finance institute definition the ROI is a financial ratio which is used for calculating the benefit of an investment would be gained in relation to the investment costs; this ratio is taken into the account as the benefit (or a return) of an investment divided by its primarily costs. As it was mentioned before in our case (as the objective of CMS implementation), the direct costs is included the technical inspection and other repairmen (or maintenance) costs also the material losses costs and the benefit of ROI is not always measured in financial metrics, but in the terms of avoidance of indirect costs (environmental, health and safety or integrity costs). The directs costs is not such a big deal and it can be calculated by a dynamic financial system (e.g. in this case Activity-Based Costing (ABC) financial system is useful tool for calculating the direct costs) but in the indirect costs some challenges may be faced to define the risks which are hard to measure in financial metrics including reputation and societal costs. In such these case according to the Delphi method and related standards, it was recommended to use the Safety pre define KPIs. The ROI in such this case taking to the consideration of risk-based concept such as "*As Low As Reasonably Practicable (ALARP)*".

In our experience, it is useful to know that in this case there are some uncertainties in quantifying both the likelihood and consequences of the corrosion costs. Such these uncertainties maybe faced both in models and gather data. Therefore, additional mitigation metrics are beyond the calculated ROI.

The useful way to illustrate the beneficial aspects of implementation of CMS is to combine corrosion technology-spec with a typical management system elements as a two by two matrix which is shown in Figure 1.

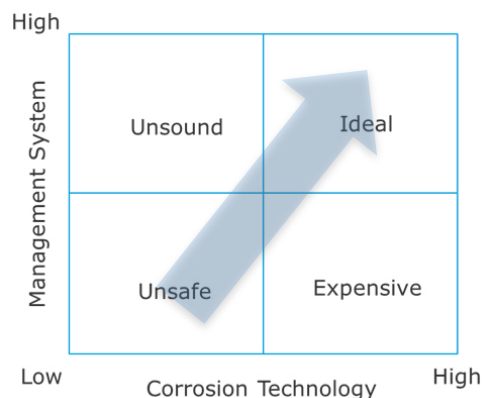


Figure 1. Corrosion Technology vs Management System Elements

In this figure within the low corrosion technology and a weak CMS, the corrosion threat is not even controlled or managed (i.e., it is called unsafe condition). By the investment on the corrosion technology and present of low CMS, corrosion phenomena is under control but not optimized (i.e., it is the expensive way). In case of maturity of management system without investment on the corrosion technology cannot be effective (i.e., the unsound situation). Combination of a mature management system and investment on corrosion technology is ideal perspective which it results in an efficient and effective management system in AIMS.

2. TERMS AND DEFINITIONS

2.1. Corrosion Management System (CMS)

As per definition on NACE IMPACT 2016 report: A typical Corrosion Management System is a set of process, procedures and policies for planning, executing, and continuous improvement and the capability of a company and organization to manage corrosion threat for existing and future assets [1]; In the most cases the CMS contains the following Critical Success Factors as below:

- The optimization of corrosion control processes and LCC (Life Cycle Cost) due to corrosion
- Concerning the objective of HSE (Health safety and Environment) goals

Based on this definition CM is a part of the overall integrated management system (IMS), which is focused on the development, implementation, review and maintain of the corrosion policy." [2]

A general corrosion management system provides a progressive framework that is fulfill the requirements of the integrated management system. The Idea is that for reducing cost of corrosion as it was illustrated in figure 1 the integrity of corrosion decision in the IMS is fully needed meanwhile the corrosion technology should be increase due to uncertainty of conditions.

A successful practice of any CMS is including the auditing and measurement of performance processes. Audit and measurement activities also contribute feedback ensuring continuous improvement in corrosion management system (See Figure.2).

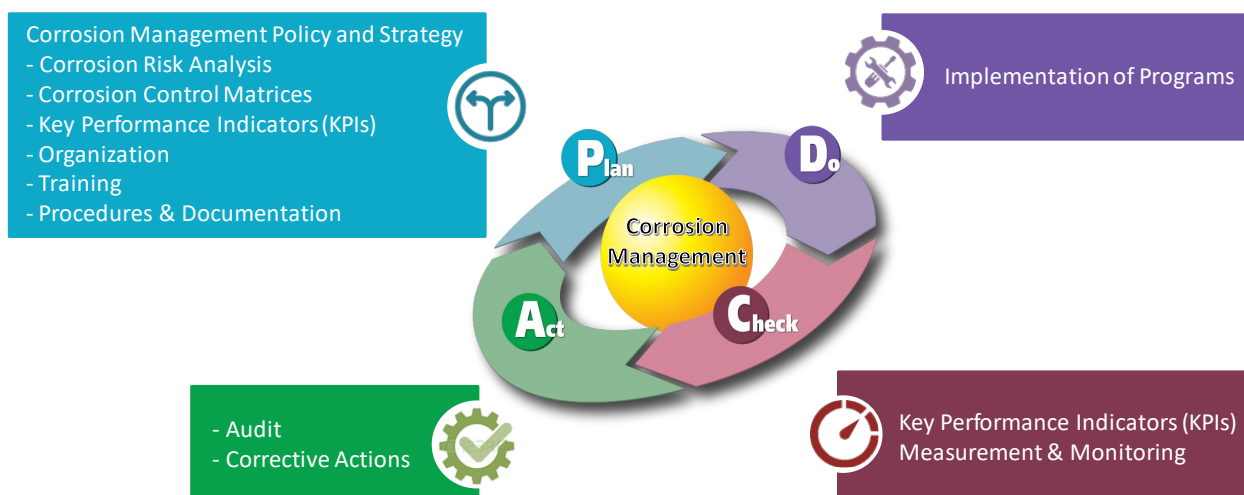


Figure 2. Corrosion Management System Continuous Improvement (Deming Cycle)

2.2. Asset Integrity Management System (AIMS)

According to the Asset Integrity Management Handbook: Asset Integrity is defined as the ability of an asset to execute its expected function efficiently and effectively while ensuring HSE requirements. Based on this Asset Integrity Management System (AIMS) is the system is established to make sure that the resources, defined processes, human capitals and the sub-systems can deliver integrity in place, and will perform their expected functions when required over the overall lifecycle of the asset efficiently and effectively [3] (Cost Benefit Analysis is fully needed).

2.3. Critical Success Factor (CSF)

A Critical Success Factor (CSF) is a very important activity (factor) required for making sure that the success of an organization will happened. The term is initially used in business analysis. [4]

2.4. Integrated Management System (IMS)

Integrated Management System is a process system which is established to develop a business model including not only the financial aspects and priorities of an enterprise but also includes metrics for

measuring an environmental performance of the enterprises. The scope of Integrated Management is not limited, as any organization (including private and public sectors, non-profit organization and etc. Also it could be utilized into the annual reports, redefining functional roles and decision making processes, and though this integration new opportunities for continuous improvement, development and value creation). [5]

2.5. Technology Roadmap and Road-Mapping

A technology roadmap is a transformative planning method to assist strategic and long-term planning, by engaging short-term and long-term objectives and goals with particular technology solutions [6], [7]. It may contain using technology forecasting and/or technology observation to recognize appropriate cutting-edge technologies. One of the main expectation of road-mapping techniques may help organization to survive in turbulent environments[6] (just like a torch) and assist them to plan in a more comprehensive method to include non-financial objective and goals and drive towards a more sustainable development.[8] Meanwhile roadmaps can be merged with other corporate prospective methods to help systemic change.[9]

Road-mapping has 3 major usages [10]. It assists to reach a general agreement about a set of requirements which the technologies must satisfy them, it prepares a mechanism to observe technology developments, and also a framework to plan and coordinate technology developments [11].

Generally, road maps of any kind and mode of presentation are used to answer the following three questions: What is the current position of the organization? Where is the organization's ultimate destination? How is it to reach the destination?

3. THE ADVANTAGES AND BENEFITS OF IMPLEMENTING CMS

As per previous experiences which is already available in the best practices organizations, it is obvious that the following benefits [12]:

- Determination of existing and potential integrity threats through Integrity Review Process
- Redesigning of mandatory mitigation or required activities
- Review of existing Corrosion Engineering principals (i.e. design, material selection and environmental controls)
- Reviewing Conventional Performance Monitoring
- Reviewing Conventional Effectiveness Assessment
- Improving HSE Protection
- Maintenance (e.g. repair and replacement)and inspection activities optimization (risk-based orientation) as per integrity management recommended
- Optimizing Chemical treatment costs
- Preventing of Corrosion Failure will cause increasing asset uptime
- Increasing corrosion awareness, improve communication and team-working
- Improved reporting
- And finally decrease the long-term direct and indirect cost of corrosion phenomena through the asset life-cycle cost

This can be summaries in two categories as below Table 1:

Table 1. The primary and secondary benefits of CMS implementation

Benefits Category	Benefits Type
Primary	Determination of existing and potential integrity threats
	Redesigning of mandatory mitigation or required activities
	Reviewing the existing Corrosion Engineering principals
	Reviewing Conventional performance monitoring and Effectiveness assessment
Secondary	Improving HSE protection
	Maintenance and inspection activities optimization (Risk-Based Orientation)
	Optimizing chemical treatment costs
	Preventing corrosion failure and relevant leakages
	Increasing assets availability
	Increasing corrosion awareness, improve communication and team-working
	Improved reporting
	Finally decreasing asset life-cycle cost due to corrosion phenomena

4. CRITICAL SUCCESS FACTORS FOR ROAD-MAPPING AND SPECIFICATION CORROSION MANAGEMENT SYSTEM

4.1. Necessity-Orientation

The roadmap should determine the activities needed to achieve the project's goal. Also, it must forecast and identify the weaknesses and problems to reach the goals and provide them with a solution.

4.2. Integrity

General agreements and consensus among project beneficiaries are required to prepare a road map.

4.3. Comprehensiveness

The developed roadmap should include short, medium and long-term goals.

4.4. Roadmap Structure

A roadmap consists of two dimensions: the time dimension shown in the horizontal axis, and then the layers that are in the vertical axis. The schema of a general roadmap is shown in Figure 3.

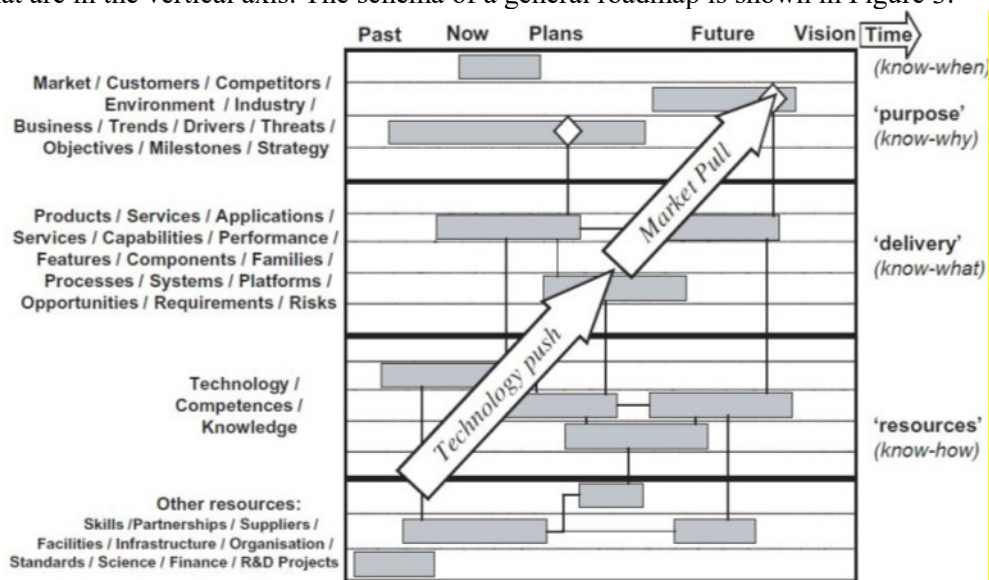


Figure 3. A typical Roadmap Schema

4.4.1. Time Dimension

In the time dimension, the order of the programs, the start and end times of each one are illustrated, thus making it easier to control the programs.

4.4.2. Layers Dimension

Layers are defined in different levels of planning in an organization. Their design is very important, and depending on the complexity of the layers, each one can be divided into a number of substrates. However, different layers can be divided into three general categories:

- Target layer
- Responsive Layers (Intermediate Layers)
- Resource layer

The target layer is at the top of the roadmap and includes the goals that the organization has set at the desired horizons. Each of these goals (and their respected time) are displayed in this layer.

The middle layers of the road map, called the responsive layers which include all activities and possible ways to achieve the goals. It should be noted that the execution time of all activities included in this section is determined and is visible in the road map. Also, the relationship between different activities with each other are shown as a linear relationship.

The resource layer contains all the resources needed to achieve the goals. In fact, the resource layer holds all of the responsive layer needs to meet the goals within a given time. The resources mentioned in this layer can be of any type. Including financial, infrastructure, knowledge, individual skills, and so on.

5. STEPS TO PREPARE A ROADMAP

5.1. Before Road-Mapping

The most important issues that are being addressed at this stage are as follows:

- Dimensions: Determine the scope of activities
- Goals: Identify the short-term and long-term goals that the organization expects to achieve at the end of the roadmap.
- Resources: All facilities needed to achieve the specified goals must be determined and recorded.
- Setting the road map framework: Due to the type of project and its targeting, the roadmap architecture should be customized.

5.2. Meanwhile Road-Mapping

At this stage, it is necessary to determine the beginning and the end of the roadmap, planning priorities, and the start and end time of the processes. Meanwhile the road-mapping, Forecasting has a critical role, in fact, the roadmap outlines the process along the way and reaches its goals in the future.

5.3. After Road-Mapping

After road-mapping, it is necessary to validate and verifying the roadmap. Also, since the roadmap is a live document, it should be periodically updated.

6. SELECTING AN APPROPRIATE MODEL FOR IMPLEMENTING THE CMS, CASE STUDY: NATIONAL IRANIAN GAS COMPANY

As the main target of the establishment of the native CMS is aimed to reducing and controlling the effective and optimal corrosion and associated costs. In order to achieve this goal, the required capabilities and organizational processes are identified, and after that, the relationship between disciplines of the organization involved in this subject, is analyzed. As a part of research project, the current status of corrosion management in pilot plants are studied. The desirable condition of the CMS is determined by the

indicators extracted from the previous national and international experiences of similar best-practices and available knowledge resources (via benchmarking process). By determining the strengths and weaknesses of the current situation and the desirable situation, as well as the prospecting for the National Iranian Gas Company in the horizon 2030 in the field of corrosion management, it is possible to establishing a native CMS for NIGC. The timeframe which is intended to roadmap from the beginning of the project (2018) up to vision of 2030. It should be noted that the end of the time frame is out of time of this project and this research project is considered as a short-term goal for the establishment of the native CMS.

Based on the studies, and using Delphi method of MCDM, the strategic road-map is chosen for this case. In strategic roadmap, there is a top-down look, that is, identifying the needs of the market, the desired business, the product and services and subsequently the technologies that lead to the production are identified; the skills needed to achieve the technology in the organization are developed and the other outside organizations which are engaged in this matter are recognized. In a strategic road map, the streamline of the current status toward the desired outlook are formed from the layers of the market, business, processes, product technology, skills, relationships and organization. This kind of road map, by analyzing the gap between the current situation and the future outlook, provides general solutions, and contributes to strategic planning by assessing opportunities and threats. Its main focus is on developing an appropriate perspective for the future of the business and products and services of the organization. Then, by assessing the status of each issue, the gap between the existing situation and the outlook is drawn. Obviously, at the end of road-mapping, the list of activities, each of which can fill the gaps could be provided. A typical strategic roadmap is shown in figure 4.

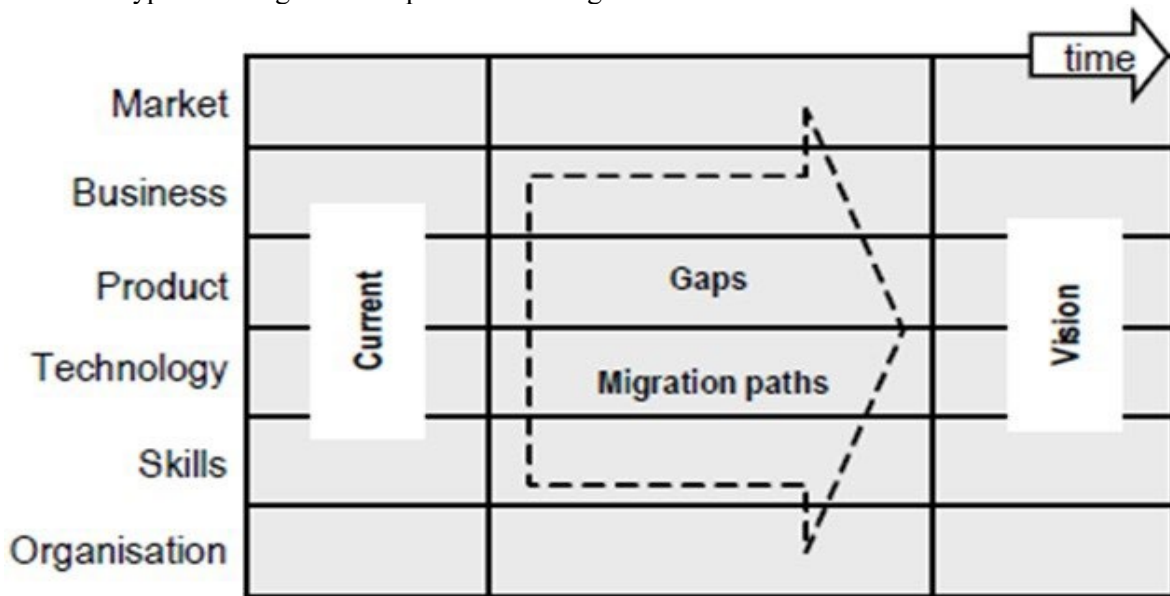


Figure 4. A typical Strategic Model Schema

7. RESULTS

Based on the nature of research projects, there is no evidence for a standard method (such as ISO55000 series for Physical Asset Management and asset integrity management) for implementation of CMS in such a big natural gas supply chain. As per client managers request, the roadmap for implementation of CMS is under study and initial results (the strategic roadmap) is shown in figure 5.

Meanwhile the process-oriented models for implementing native CMS in chosen pilot plants (including engineering and development projects, gas sweetening plants, a district of gas transmission pipeline including gas compressing stations) are under development.

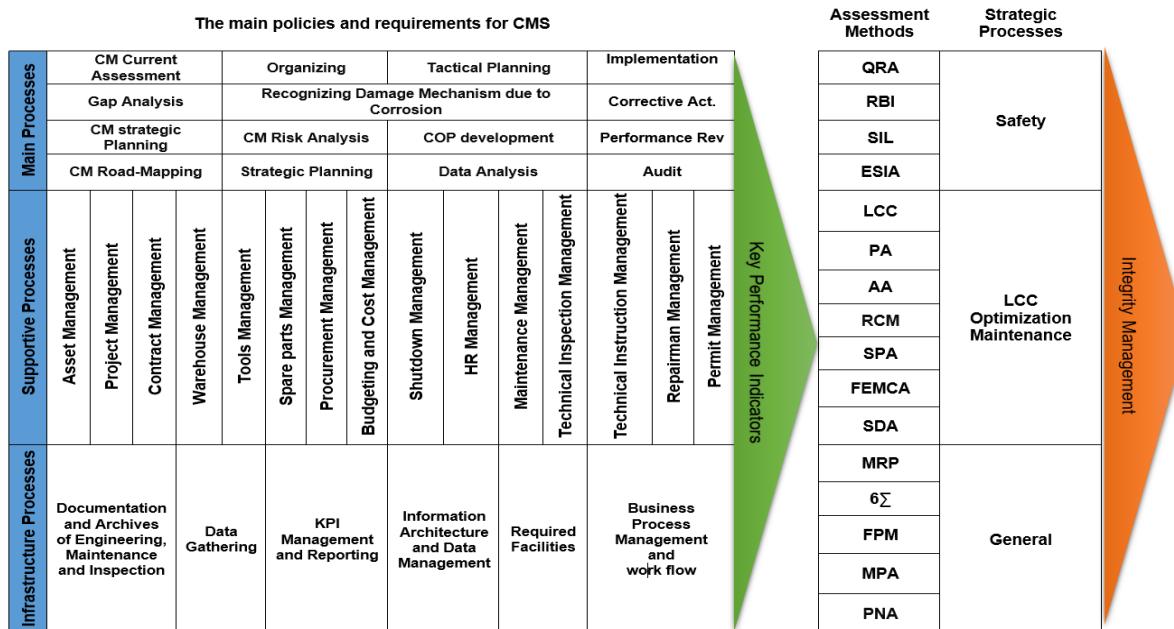


Figure 5. NIGC CMS Strategic Model

8. CONCLUSIONS

As per ISO 55000 standard series for Physical Asset Management (PAM) requirement mentioned, Corrosion Management is an critical asset management tool, and recommended to imitate it from early engineering steps during conceptual design stages of a new projects up to end of life-cycle of any plants and assets.

The recent developments and so the standard approaches are focused on risk-based orientation strategies and also integrity management practices. The case study is determined that major cost savings will be occurred by developing a risk-based approach that includes both technical inspection and corrosion management strategies.

To establish a successful corrosion management system is only applicable through management commitment, effective communication, teamwork, and making sure that the capable personnel are present in the project team.

In this case study, a research project is defined and the main target set to establish a native corrosion management system in order to reduce and control the effective and optimal corrosion and associated costs. As the nature of research projects, where there is no evidence for a standard method for implementation of CMS (like ISO55000 standard series requirements for PAM) in NIGC, and client managements request, the roadmap for implementation of CMS is under study and initial results (the strategic roadmap) is shown in figure 5.

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BIOGRAPHY

Ali Massaeli: Ali is the head of the supervision guidelines and methods development in technical inspection and control affairs of National Iranian Gas Company, Tehran- I.R. of IRAN. He earned B.Sc. in Chemical Engineering from Azad University of South Tehran; M.Sc. in Industrial Engineering – System Management and Productivity from Azad University of Qazvin.

He became the charter member of ISIRI ISO TC 193 (Natural Gas Standards) in Iranian National Standards Organization also Iranian Gas Standardization Affairs.

He has several research activities such as publishing internal journal of IGU (International Gas Union) and several international conference papers. He has several industrial training courses in oil and gas processing and Industrial Engineering and co- authoring and the editor of process engineering in oil and gas industry. He was one of the senior experts in SCOPE integrating executive committee of Petroleum Ministry of I.R. of IRAN.

In the IEOM 2012(Istanbul-Turkey) he received Outstanding Industry Awards. He is one of the members Industrial Committee of IEOM since 2012 till now. Also he is member of jury team of International Management Conference since 2010 in managerial experience section.