ISBN-978-989-53228-8-6
41st ISTANBUL International Conference on "Education, Marketing, Social Sciences & Humanities" (IEMSSH-22)
Istanbul (Turkey) Mar. 21-23, 2022

Badak LNG Maintenance Department Performance Measurement System Development

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Abstract: *Badak LNG is a liquefied natural gas (LNG) processing company in Indonesia. As one of the business units in Badak LNG, the Maintenance department requires an integrated and contextual performance measurement system that can measure the system performance, monitor the status, and provide appropriate feedback for continuous improvement. However, the maintenance department has no integrated performance measurement system, which translated from corporate and mission and vision. To develop performance of a maintenance management system, performance improvement efforts need to pay attention to the factors that make up the contextual maintenance management system. This research aims to develop a strategic maintenance performance measurement system using a combination of the Balanced Scorecard (BSC) with Amendola's Four-Stages Model framework. Furthermore, performance indicators are selected using the statistical method obtained from questionnaires distributed to all production divisions in Badak LNG, as the maintenance management system stakeholders. In addition, the research analyzes the relationship between attributes in the maintenance management system using correlation and comparison methods using the Analytical Hierarchy Process (AHP) method. Implementing the new performance measurement system is hoped to help the maintenance department make decisions in managing the maintenance system more effectively to realize and achieve its mission and vision. This research is limited for developing a new performance measurement system using the Five-Stages and BSC framework to manage the maintenance system at Badak LNG.*

Keywords: *Analytical Hierarchy Process (AHP), Badak LNG, Balanced Scorecard (BSC), Maintenance, Performance Measurement System.*

1. Introduction

Badak LNG is a non-profit Liquified Natural Gas (LNG) processing company located in Bontang, Indonesia. As a part of the LNG business chain, Badak LNG must carry out its functions properly to support the target of the overall LNG business to process natural gas into LNG as much as possible. As one of the business units in Badak LNG, the maintenance department is responsible for maintaining the LNG plant and all its supporting facilities in a reliable, effective, and safe manner and according to the approved budget. In this case, such companies may benefit from using a contextual performance measurement system to measure the system performance, monitor, and provide appropriate feedback for continuous improvement.

There is no integrated performance measurement system in the maintenance department, which translates from vision, mission, and strategic objectives of corporate and division level. The variables and indicators of the current performance measurement system are not integrated and in line with the company's

strategic objectives. To improve the performance of the maintenance management system, especially in non-profit LNG companies, performance improvement efforts need to pay attention to the factors that make up the contextual maintenance management system. In this case, adjustments should be prioritized on the factors that have the greatest impact on the financial and customer perspectives. The expectation from the customer is that the LNG plant has to be always available and reliable. Meanwhile, efforts to achieve the plant condition are largely determined by how the maintenance business process is carried out and the involvement of the human resources.

2. Literature Review

Several methods for measuring maintenance performance have been proposed in the pieces of literature. Dwight (1999) recommends using system auditing methods to measure the performance of the maintenance system's contribution to business success, called value-based performance measurement. It includes the impact of activities on the future value of the organization, such as maintenance activities. Some authors advocate using metrics such as the maintenance productivity index, which measures the ratio of maintenance output to maintenance input. The most obvious disadvantage of this approach is that it gives a very limited view of service performance and the more subtle problem of identifying different types of service costs. Tsang (1998) proposes a strategic approach to maintenance performance management using the well-known balanced scorecard. (Kaplan and Norton, 1992; Kaplan and Norton, 1996) explained the success of a balanced scorecard approach depends on the fact that strategy has a strong and positive impact on the firm's performance.

Amendola (2003), Ahlmann (2002), Ellingsen et al. (2002), and Biasotto, Dias, and Ogliari (2006) recommend the use of a balanced scorecard (BSC) method to integrate a specific maintenance strategy system into the evolution of the entire plant. Maintenance is a strategic function in the company's business, especially for companies with continuous processes and high downtime costs. BSC application has led to excellent results since its popularization in 1992 by its two authors, Robert Kaplan and David Norton. In its four perspectives, Dunn (2003) re-exams the Balanced Scorecard for the maintenance process. Amendola (2005) states that the BSC's main advantage is to simultaneously consider the four perspectives, establish a "cause-effect" network between them, and provide strategic initiatives on each level. Based on the literature review, the Balanced Scorecard (BSC) is a favorable and recommended performance measurement system for maintenance context because of its expansive thought of all business viewpoints. The objectives and measurements of the scorecard are derived from an organization's vision and strategy based on four different perspectives: financial, customer, internal business processes, as well as learning and growth. The various measures across the four perspectives can be linked in a series of cause-effect relationships.

3. Methodology

This research employed literature review and case study methods to build a new performance measurement system for maintenance management in a non-profit company. The literature covered articles about the use of the Balanced Scorecard method to integrate a specific maintenance strategy system into the evolution of the entire plant developed by Robert Kaplan and David Norton (1992), Amendola (2003), Ahlmann (2002), Ellingsen et al. (2002), and Biasotto, Dias, and Ogliari (2006). This framework was selected because the company's strategies can be translated into operational terms, where measures of past performance are enhanced with standards of the drivers of future performance. The step-by-step development process of the performance measurement system in Badak LNG is shown in Figure-1.

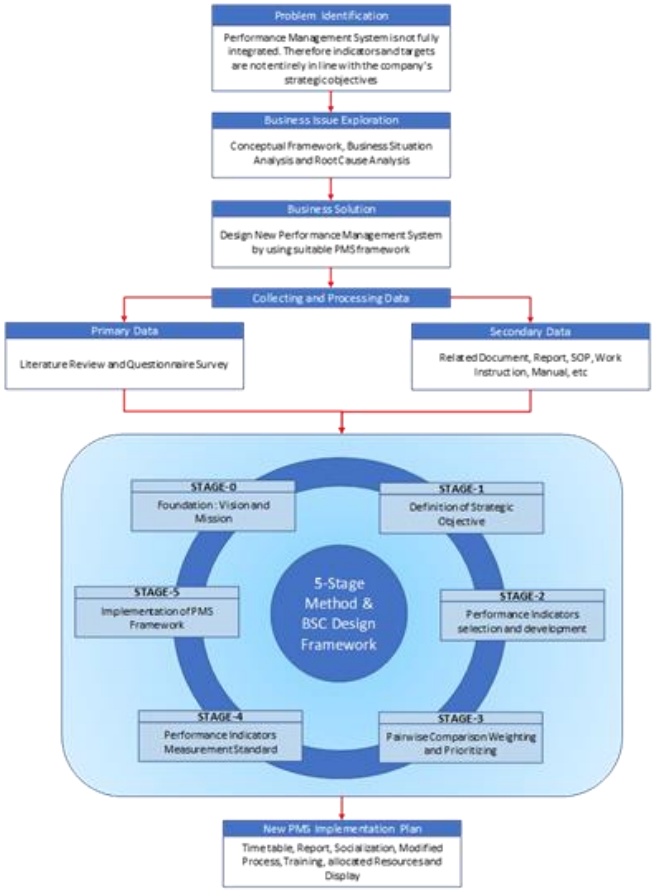

Fig. 1 The 5-Stages BSC Model Framework.

The 5-Stages BSC Model framework of Performance Measurement System (PMS) applies a combination of the Balanced Scorecard (BSC) method with the Four-Stages Model method introduced by Amendola (2003). The framework consists of deploying the company's strategic objectives, starting from the maintenance department vision and mission in the company's process up to the performance indicators and their popularization in a top-down manner. The sequence allows capturing maintenance department strategic objectives, translating them into a measurement system through performance indicators concerning various strategic and operational situations that the maintenance structure can pass through. In way to use the BSC methodology to a maintenance structure, the Five-Stages method will be described as follows:

3.1. Stage – 0 : Foundation

Before starting PMS development in the maintenance department, it is necessary to determine or redefine the vision and mission of the maintenance department, which must be in line with the company's vision and mission. Based on the maintenance department's vision and mission as the PMS foundation, strategic objectives can be determined for further cascading down into a set of performance indicators and targets using the Balanced Scorecard framework.

3.2. Stage – 1 : Strategic Objective

The Strategic objective map must describe what a company owns internal processes in line with existing strategies. A strategic objective map is a picture that connects between factors that exist on an organization's critical success factor. It also describes the strategy, goals, and measurements (Kaplan and Norton, 2004: 176). As indicated by Kaplan and Norton (1992), in Balance Scorecard, the execution

variable comprises four points of view: financial, customer, internal process, and learning & growth perspectives. In this stage, the initial step in defining the strategic objective of the Badak LNG maintenance department is translating vision and mission into strategic issues. BSC uses dynamic questions to define the strategic objectives to reach the organization's mission, and consequently, its vision, as shown in the following figure 2:

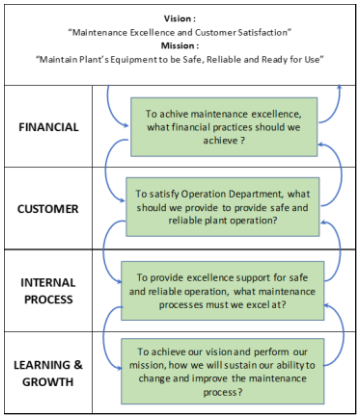

Fig. 2. BSC dynamic questions to define strategic objectives

Figure 2 illustrates a series of questions to determine strategic objectives derived from the vision and mission within the balanced scorecard framework. All four BSC perspectives will take shape by beginning with the financial perspective. The strategic objectives are strategies that the maintenance department must perform to succeed in maintenance management.

3.3. Stage – 2 : Performance Indicator

Performance indicators are introduced to evaluate maintenance staff actions to accomplish the strategies related to each strategic objective defined in all BSC perspectives. To further analyze the relationship between strategic objectives and each of its performance indicators, a cause and effect linked strategic map is developed to describe the indicator's compatibility with the strategic objectives. To BSC reflects the organization strategies, it is fundamental that the four perspectives reflect the cause-effect relations between them because the strategy is a set of hypotheses on cause and effect analyses.

3.4. Stage – 3 : Pairwise Comparison Weighting

Furthermore, based on the performance indicator hierarchy, the weight of all perspectives, strategic objectives, and performance indicators are calculated using the pairwise comparison method. The calculation purpose is to determine the contribution level and priority of each parameter to the performance achievement of the maintenance department. For this purpose, AHP (Analytical Hierarchy Process) software is used based on survey data from several Subject Matter Experts (SME).

3.5. Stage – 4 : Standard, Target and Benchmarking

After developing key performance indicators, the next step is to manage performance targets. To overcome double standards and inconsistencies in evaluating the company's performance, this research proposes using internal and external benchmarking and capturing stakeholders' aspirations to select targets. Calculation or determination of performance measurement standards can be done based on historical or trending data from previous achievements (internal benchmarking) or benchmarking against standards that apply nationally or internationally (external benchmarking).

3.6. Stage – 5 : Implementation

PMS implementation creates a system used in the Maintenance Department to update periodically, calculate, monitor, and report performance achievements. For this purpose, it is proposed to have a PMS report as a strategic tracking method that will help Maintenance Department improve performance by efficiently tracking progress against targets. These reports compile performance indicators into charts, graphs, and tables that make it easy to visualize how Maintenance Department performs.

4. Result

The maintenance department describes its vision to deliver "Maintenance Excellence and Customer Satisfaction" and its mission to "Maintain Plant's Equipment to be safe, Reliable and Ready for Use." Based on the vision and mission and implementing stage-0 to stage-4 of the PMS development framework, the strategic objectives and performance indicators for all BSC perspectives completed with weight factor and standard target have been developed, as shown in Table 1.

TABLE I: The Arrangement of Channels

BSC PERSPECTIVE	Strategic objectives	Performance indicators	Weight (%)	Target per Year	Benchmark Standard
Financial	Budget Variance	Maintenance Operating Expenditure (OPEX) Deviation	8.4%	Max 3%	Phillip Townsend Associates
		Project Capital Expenditure (CAPEX) Deviation	4.1%	Max 3%	Phillip Townsend Associates
	Budget Effectiveness	Unbudgeted Program	8.4%	Max 5%	Company Target Policy
		Wrong Allocated Program	4.1%	Max 5%	Company Target Policy
Customer	High Availability	Maintenance Related Plant Downtime	24.5%	Max 10 Days	Badak LNG History 97%
	High Reliability	Equipment Related Plant Trip	24.5%	Max 2 Times	Badak LNG Best Record
Internal process	Maintenance Process Effectiveness	**Work Identification**			
		Percentage of Preventive Work	2.3%	Min 80%	World Class Maintenance
		Precentage of Reactive Work	0.6%	Max 15%	
		Precentage of Improvement Work	0.5%	Max 10%	
		Work Request Response Time	0.6%	Min 80%	
		Work Planning			
		Planning Intensity Rate	1.3%	Min 95%	World Class Maintenance
		Quality of Planning	1.6%	Max 3%	
		Planning Responsiveness	0.6%	Min 80%	
		Work Scheduling			
		Scheduling Intensity	1.0%	Min 80%	World Class Maintenance
		Quality of Scheduling	1.3%	Max 2%	
		Scheduling Realization Rate	0.9%	Min 95%	
		Work Execution			
		Schedule Compliance	1.0%	Min 90%	World Class Maintenance
		Backlog Size	0.5%	Max 10%	
		Work Order Turnover	0.4%	Min 90%	
		Quality of Execution (Rework)	0.5%	Max 3%	
		Manpower Utilization Rate	0.3%	Min 80%	
	Material Inventory Performance	Inventory Accuracy	0.6%	Min 95%	World-Class Inventory Best Practices
		Stock Out	0.3%	Max 2%	
		Emergency Purchases	0.3%	Max 5%	
		Slow Moving Parts	0.1%	Max 5%	
		Services Level	0.3%	Min 95%	
	HSE Performance	Work Accident	1.6%	0	Company Target Policy
		Fire Incident	1.0%	0	
		Road Traffic Accident	0.3%	Max 3	
Learning and growth		Maintenance Training	2.7%	Min 87400 Man-hours	Company Target Policy

The outcome shows that the customer perspective is the top priority for the maintenance department. It is in line with the vision of the maintenance department, which strives for maintenance excellence for customer satisfaction. Meanwhile, another perspective supports the implementation of the maintenance department's mission to maintain and ensure the condition of the LNG plant in an efficient, safe and reliable manner and with the support of human resources that are always developed.

5. Conclusion and recommendation

Based on the evaluation on the current performance measurement system compared to the new system, these are conclusions and recommendations which can be delivered:

- It is identified that the current performance measurement system implemented at Maintenance Department is not fully aligned with its mission and vision. It is observed that there was no corporate mission and vision translation process into maintenance department strategic objectives within the organization's level of structure. The aspects, objectives, and performance indicators are similar at each level of the company organization.
- To evaluate the performance of the maintenance function, it is imperative to have a well-formulated maintenance strategy based on the corporate mission and vision. The approach should then encapsulate maintenance processes that are critical success factors contributing to production and business success.
- To improve the current performance measurement system in the maintenance department, the factor must include aligning maintenance with strategic production objective, maintenance effort or process (leading indicator) analysis, and maintenance results performance (lagging indicator) analysis.
- Based on the 5-Stages Method and BSC Design framework, 32 performance indicators have been developed to measure the performance of the maintenance department in Badak LNG

This new performance measurement system that relies on the Balanced Scorecard is set to run in the maintenance department business unit. The new performance measurement system must be consistently surveyed for constant change during implementation. Continuous improvements must be made to get a well-established execution administration framework. It is also necessary to forecast changes with external or internal conditions for continuous development. To ensure that the implementation of this new system can be carried out properly and in a targeted manner, several components need to be carried out, such as plan scheduling of implementation, report, socialization, modified process, training, allocated resources, and display.

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