TEST Engineering & Management

May – June 2020
ISSN: 0193-4120 Page No. 9907 - 9912

Implementation of Computerized Maintenance Management System based on Conceptual Strategic Asset Management Maintenance Framework for Oleochemical Industry

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Article Info
Volume 83
Page Number: 9907 - 9912
Publication Issue:
May - June 2020

Abstract:

Oleochemical industry is expanding rapidly due to surge in global production and demand. Modern Oleochemical plants are being erected in Malaysia and Indonesia. These modern plants with excellent raw material integration, gives producers in ASEAN an importance competitive advantage over other global competitors. In order to ensure the industry stays competitive with reliable operation and maximize the return of the capital investment, it is prudent to have all invested assets to perform their design intended function in a safe, effective and efficient manner. This can only be achieved through established asset management system. However, one of the major challenges in Oleochemical industry is managing sophisticated assets with deficient asset management system to maintain production. Technology advancement and effective deployment of information technology in support of maintenance has created new options for maintenance such as computerized maintenance management framework (CMMS) which allow seamless flow of asset maintenance information and performance measurement. CMMS is computer-based software programs used to control work activities and resources used, as well as to monitor and report work execution which in turns become part of asset history. CMMS also served as a tool for data capture and analysis. It provides management with value added information necessary for maintenance decision making. CMMS often seamlessly links with enterprise resources planning (ERP) system to improve overall asset performance, such as from breakdown maintenance to preventive maintenance. Recognized the complexities in maintenance, the industry needs to leverage the new advancement in technology and CMMS to support maintenance function and as a basis of asset management system. Without a proper asset management framework, structural CMMS is hard to be established in Oleochemical industry. Therefore, it is important for oleochemical industry to implement CMMS based on conceptual strategic asset management maintenance framework in order for this industry to stay competitive. However, there is a need for theoretical as well as empirical research in the future to validate the multifaceted perspective in the present study and to obtain more insights into the nature of asset maintenance and management, to further improve the conceptual framework to suit the Oleochemical or other similar industry.

Keywords: *Asset Management System, Computerized Maintenance Management System, Maintenance Framework, Oleochemical.*

Article History
Article Received*: 19 November 2019*
Revised*: 27 January 2020*
Accepted*: 24 February 2020*
Publication*: 18 May 2020*

TEST Engineering & Management

May – June 2020
ISSN: 0193-4120 Page No. 9907 - 9912

I. INTRODUCTION

Oleochemical industry is one of the major contributors to the Malaysian economy, plays a leading role as global oleochemical producer and exporter. Oleochemical plants are built in Malaysia since 1980s, today the largest and most modern Oleochemical plants are being erected in Malaysia and Indonesia [1]. In order for the industry to stay competitive in managing enormous number of production assets, e-Maint such as computerized maintenance management system (CMMS) is introduced to help improve asset management. With the rapid advancement of technology over the last decade, CMMS enables organization to plan, track measure and collect more information on assets to make smarter, data-driven decisions [2]. However, there is no specific standard, or framework in guiding the implementation of CMMS [3] which define the need of this research.

II. REVIEW

A. Asset Management

The first specification covering management of assets was published by the British Standards, PAS55 in 2004. It structured around the familiar Plan-Do-Check-Act cycle of continual improvement and introduces the need for a number of essential enablers for the optimized management of physical assets [4]. Subsequently ISO 55000 series of Assets Management Standards was launched in January 2014 covering management of assets of any kind. It provides overview of asset management, its principles and terminology [5], and the expected benefit from adopting asset management while ISO 55001 specifies requirement for an asset management system within the context of the organization [6] and ISO 55002 provides guideline for the application of ISO 55000 [7]. In the same year of 2014, European Standard, EN 16646 introduced physical asset management as a framework for maintenance activities. It also introduces the relationship between organization strategic plan and maintenance management system. It decries the interrelations between maintenance process and all the other physical asset maintenance processes. It addresses the role and importance of maintenance within physical asset management system during the whole life cycle of an asset [8]. Indeed, there are similarities between all standards as summarized in below Table 1, but still there is no specific guideline on CMMS implementation for any industry.

	PAS 55	ISO 55000	ISO 55001	ISO 55002	EN16646	GFMAM
Background and introduction	Inclusive	Inclusive	Inclusive	Inclusive	Inclusive	Inclusive
Asset Management System Requirement	Inclusive	Inclusive	Inclusive	Inclusive	Inclusive	Inclusive
Roles and Leadership	Inclusive	Not inclusive	Inclusive	Inclusive	Inclusive	Inclusive
Asset Management System Planning	Inclusive	Inclusive	Inclusive	Inclusive	Inclusive	Inclusive
Risk Assessment and Management	Inclusive	Not inclusive	Inclusive	Inclusive	Not inclusive	Inclusive
Asset Lifecycle Management Plan Implementation	Inclusive	Not inclusive	Not inclusive	Not inclusive	Inclusive	Inclusive
Maintenance Management and Execution	Not inclusive	Not inclusive	Not inclusive	Not inclusive	Inclusive	Inclusive
Performance Assessment and Review	Inclusive	Not inclusive	Inclusive	Inclusive	Inclusive	Inclusive
Continual Improvement	Inclusive	Not inclusive	Inclusive	Inclusive	Not inclusive	Inclusive

Table 1: Summary of Similarities between Asset Management Standards

B. Maintenance Framework

In year 2016, an association of professional maintenance and asset maintenance societies known as the Global Forum on Maintenance and Asset Management (GFMAM) is formed for the purpose of sharing collaboratively advancement, knowledge creation and sharing on maintenance and asset maintenance. The maintenance framework as published by GFMAM in year 2016 is to provide an overview of the discipline of maintenance management with the documentation of five principles and seven subject groups as part of maintenance management landscape [9] is stipulated in Figure 1.

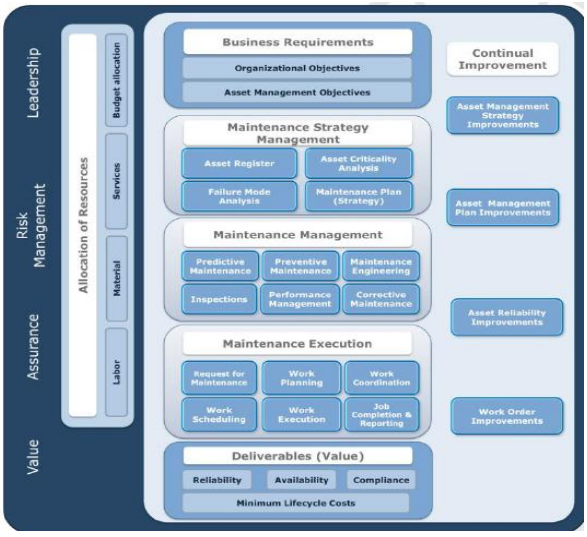

Figure 1: The Maintenance Management Framework Diagram (GFMAM, 2016)

TEST Engineering & Management

May – June 2020
ISSN: 0193-4120 Page No. 9907 - 9912

C. Computerized Maintenance Management System (CMMS)

Communicating and tracking anything can be difficult if without a system. Based on the current industry trend, the rise of the industrial internet of things (IIoT) is making it possible for organizations to implement digital solution such as intelligent maintenance software to collect data and manage maintenance operation [10]. Asset-intensive industries today are experiencing aging infrastructure assets and increasing stakeholder expectations. This results in increasing asset maintenance and management needs to ensure production uptime and asset reliability are met. Fundamental concept of CMMS is designed to drive asset uptime with key capabilities to manage maintenance by maintenance teams. CMMS is the perfect tool to address planning and scheduling of maintenance tasks, a strategic and paradigm shift from conversion maintenance management towards operational excellence [11]. However, most details of setting up, implementation and configuration of CMMS is brand-specific. The most important modules in a CMMS are asset register, maintenance strategy, plan, task and scheduling, labor and inventory assignment and work orders management. Summary of key plant maintenance (PM) modules which enable CMMS implementation from various CMMS is tabulated in Table 2.

	Fiix	UpKeep	CWorks	MEX	Maximo	SAP PM
Organization Structure	**Standard Module**					
Work Center and Personnel	✓	✓	✓	✓	✓	✓
Asset Management	**Standard Module**					
Equipment Specification	✓	✓	✓	✓	✓	✓
Equipment Type Grouping	✓	✓	✓	✓	✓	✓
Criticality Assignment	✓	✓	✓	✓	✓	✓
Asset Tracking and Cost History	✓	✓	✓	✓	✓	✓
Bill of Material or Parts	✓	✓	✓	✓	✓	✓
Maintenance Management	**Standard Module**					
Service Requests/Notification	✓	✓	✓	✓	✓	✓
Work Orders	✓	✓	✓	✓	✓	✓
Standarized Task Lists	✓	✓	✓	✓	✓	✓
Maintenance Plan and Schedule	✓	✓	✓	✓	✓	✓
Inventory	**Different Module (Require Integration)**					
Inventory Tracking	✓	✓	✓	✓	✓	✓
Purchase Requisitions	✓	✓	✓	✓	✓	✓
Reporting	**Standard Module**					
Key Performance Indicator	✓	✓	✓	✓	✓	✓
Asset/Part/Maintenance Records	✓	✓	✓	✓	✓	✓

Table 2: Summary of Key PM Modules from various CMMS

III. CONCEPTUAL STRATEGIC ASSET MANAGEMENT MAINTENANCE FRAMEWORK

Strategic asset maintenance management for various physical equipment, process and facility assets is a sound and essential approach in order to improve asset availability and reliability. Successful implementation of CMMS requires strategic framework in order to get the most value out of the system [12]. A conceptual strategic asset management maintenance framework is developed from multiple successful CMMS roll-out and implementation in oleochemical industry as depicted in Figure 2. The framework comprises those key elements from above asset management standards and maintenance framework as reviewed which can be further developed and modified for other similar industry. Most importantly the framework also applies Deming Cycle or PDCA which promotes continuous improvement in order to improve overall asset performance throughout its service life.

A. Asset Registration

In every CMMS implementation, establishing asset master record is the key which includes all basic information that identifies each asset in order to track and monitor each asset or equipment condition and record such as indicating the status of an asset, preventive maintenance and schedule [13]. The assets identification numbers and extend of the asset master hierarchy such as parent and component relationships are normally organization or plant specific. Asset category or object type normally is defined for each asset in order to meet the organization's information needs such as managing a group of similar types of asset or equipment for ease of tracking, reporting and data selection throughout the system. Besides that, under the same function, similar types of equipment can be updated and standardized its preventive maintenance schedules instantly [14] This approach applies on any new or modified equipment to ensure all assets, especially critical ones are thoroughly reviewed and registered into the master list.

B. Criticality Analysis

Asset dependent organization or plant emphasizes about the importance of classifying assets in terms of the impact of asset failure to the organization. This is accomplished by evaluating each asset failure consequences against risk criteria within business impact factors. Each business impact factors and criticality are defined based on organization or plants

May – June 2020
ISSN: 0193-4120 Page No. 9907 - 9912

acceptable risk criteria. Typically, business impact factors of safety, quality, throughput and cost are used for the asset risk evaluation. Each consequence's risk number is either added or multiplied against each other which resulting in a numerical criticality score known as risk priority number or RPN. It enables systematically arrive at an agreement about which asset groups are non-essential to operations, essential to operations or critical to operations by their function of importance. Thereby, appropriate attention and resources can be allocated specifically for the care of critical assets. With the scarce and limited resources, asset-intensive organization that embrace the asset criticality assessment approach will facilitate effective asset management [15].

C. *Maintenance Strategy*

A maintenance strategy defines the rules for the sequence of planned maintenance work. There is no one size fit all approach to maintenance. Asset-intensive organization typically employing either breakdown maintenance such as run-to failure or preventive maintenance on a fixed predetermined interval. However, depending on above critical assessment, based on the value of the asset or its criticality in the plant's operation, predictive or even reliability centered maintenance can be used on critical assets with identifiable failure modes that affect system function which can be detected and mitigated at earlier stage. However, it requires vast investment of time, money and resources to implement such strategy. Different maintenance strategies are evaluated and summarized in below Table 3 [16].

Strategy	Summary	Cost to Implement	Pros	Cons
Reactive	Fix it when it breaks	Low	Ideal for low-priority equipment	Can lead to runaway repair costs
Preventive	Maintenance on a predetermined schedule	Average	Best strategy to implement without expertise	Without optimization, "PM creep" can occur
Predictive	Condition-based monitoring triggering work orders	High	Timely and informed monitoring. More insight into causes of breakdowns	Can be expensive to set up
RCM	Investigation of failure modes to determine best maintenance strategy	Highest	If executed properly, provides the most efficient maintenance schedule	Requires time, skill and financial resources to be effective

Table 3: Maintenance Strategies Comparison (Fiix, 2019)

D. *Maintenance Plan and Task List*

A maintenance strategy as assigned to an asset or equipment normally contains general information such as task lists and maintenance plans as required. It contains maintenance packages in which the following information is defined such as the interval or cycle of task to be performed and event that triggered the plan such as time based or condition based [17]. For those assets under the pressure directive and legal requirements, normally regular fixed interval time-based maintenance is required as part of effective preventive maintenance. This can be applied to similar group of assets based on the asset categorization and similar object type as discussed above.

E. *Scheduling*

Scheduling parameters normally contains the scheduling data for the respective maintenance strategy, plan and task. It defines the call horizon before the actual maintenance is due for execution [18]. Within a maintenance strategy, different scheduling indicators and unit of measurement can be used to specify the cycle duration either by time-based, key date, working calendar or running hours.

F. *Material and Resources Planning*

Material and resources planning are part of asset management. It triggers inventory control system based on maintenance programs from CMMS to ensure spare parts inventory and resources as needed are available in order meet the maintenance, repair or overhaul (MRO) schedule. Although the inventory system can be an independent program to some CMMS, however the inventory database can be integrated with CMMS to enable maintenance operator or planner to check against stock level, determine and reserve the spare parts and consumables as needed to carry out the MRO. This intended function helps maintenance practitioners to do their jobs more effectively at the same time to prevent stock out in particular for those critical assets by maintaining the lowest possible essential spare parts in store and reserve stores stocked parts for each planned work order. This can be achieved by a fully integrated digital solution in inventory management which enable real time stock level monitoring and planned reorder to meet maintenance needs [19]. In

May – June 2020
ISSN: 0193-4120 Page No. 9907 - 9912

addition, report on each work order costs can be generated from CMMS with all purchase order records and spare parts as utilized throughout the asset life cycle.

G. Execute, Evaluate and Improve

Execution of work order is an integral part of the CMMS in maintaining asset throughout its life cycle. It is a formal digital or paper document that describes maintenance work that is approved for execution either based on work notification or from the CMMS planned and scheduled maintenance task on certain asset [20]. Continuously data collection from work orders by CMMS supports data driven, decision making for any future asset maintenance, renewal and refurbishment needs. Asset data can be collected at the time an asset is created and at any other time in its life cycle. Dependent on accurate asset data, detailed spare parts, condition and performance of each asset can be instantly available which enables maintenance practitioners to continuously evaluate and improve existing asset maintenance management which will lead to increase in cost effectiveness, reliability, machine uptime and a greater understanding of the level of risk that the organization is managing on all key assets. Apart from above, via CMMS any breakdown orders logged will trigger root cause analysis (RCA) based on standardize information such as damage mode, cause and other details that are uniformly define. This function enables subsequent analysis by maintenance practitioners on damage profile. Knowing the failure rate and common cause can then optimize preventive maintenance intervals, improve failure response and maintenance work practices [21], which leads to net improved asset availability, safety and reliability.

CONCLUSION

The objective of this conceptual framework is to increase the extent and effectiveness of maintenance practitioners in implementing CMMS to manage and maintain assets strategically throughout assets life cycle. Rapid development and advancement in IIoT such as implementation of CMMS in primary industry has transformed the way of asset management and maintenance. Organizations or industry such as oleochemical that are quickly embracing as well as investing in this digital solution will have more advantage to explore the potential of asset deliverables with better controllable risk, greater availability and reliability. However, still many important research questions and technical input needs remain such as maintenance strategy selection in order to further develop, improve and perfecting this framework for all other organizations with different kind of assets.

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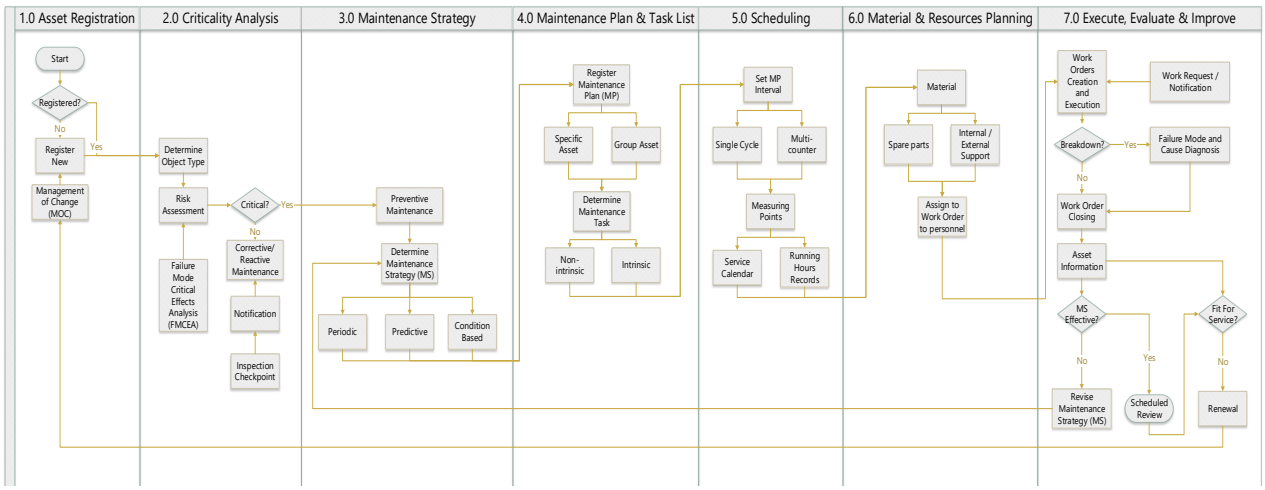

Figure 2: A Conceptual Strategic Asset Management Maintenance Framework