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An Approach to Manage and Evaluate Asset Performance

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Abstract**—**Modern engineering assets are complex and very high in value. They are expected to function for years to come, with ability to handle the change in technology and ageing modification. The aging of an engineering asset and continues increase of vendors and contractors numbers forces the asset operation management (or Owner) to design an asset system which can capture these changes. Furthermore, an accurate performance measurement and risk evaluation processes are highly needed. Therefore, this paper explores the nature of the asset management system performance evaluation for an engineering asset based on the System Support Engineering (SSE) principles. The research work explores the asset support system from a range of perspectives, interviewing managers from across a refinery organization. The factors contributing to complexity of an asset management system are described in context which clusters them into several key areas. It is proposed that SSE framework may then be used as a tool for analysis and management of asset. The paper will conclude with discussion of potential application of the framework and opportunities for future research.

Keywords**—**Asset management, performance, evaluation.

I. Introduction

CLASSICAL techniques in asset management involve performance monitoring, process control and fault diagnosis techniques that aim to determine the limit of the asset's service life. Theoretically, replacement should be made at the time when a component of an asset is about to fail so that the full service value of the asset can be utilized. However, this is not possible as modern assets are increasing in complexity and sophistication. Moreover, many additional factors are always governing the management of the asset.

Modern assets are complex and very high in value. They are expected to serve for years to come with ability to handle the change in technology and customers' demands. Literatures are showing that the consideration for the sustainment of an asset should be engaged at the very early stages of asset management system development. Asset stakeholders are demanding more value out of their asset by ensuring sustainability in operation. These include availability, readiness, extended operation and other value schemes. Literatures show that asset management industry is proposing a holistic asset management system approach [1], [2]. However, the challenge is how to holistically evaluate the performance of the asset management, ether if it is in-house management or contracted management.

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As the asset stakeholders intend (in some cases have) to outsource the support and asset management activities, the service provider will take significant part of the risk of sustaining capabilities of the asset for the duration of the service [3]-[9]. In other words, the performance of the asset will relay or directly affected by service and support provider(s). It is to the interest of the asset owners and asset manager that the asset does perform as they wish. Hence, the relationship between the asset management stakeholders should be clearly drawn and understood in regard to the implication and the nature of performing together to get the most out of the system.

Asset performance measurements depend on good data that is analyzed with sound methods [10] and be translated into information and knowledge allowing decisions to take place. Industry often complain of information overload and difficult to allocate. Asset managers complain that they do not have all the relevant information to make sound and well-informed decisions. To identify what parameters to measure, it is needed to first understand what to change to improve performance and subsequently, identify what are the measuring parameters.

This paper is proposing a methodology to evaluate and calculate the performance of an asset management system. This methodology was built on the principles of the system support engineering.

II. System Support Engineering (SSE)

SSE concept involves the integration of service and system engineering to design support solutions. It incorporates a core knowledge base, drawing upon principles derived from a wide range of business and engineering disciplines. SSE is "solution centered", delivering output solutions which are a mix of service and product. Service is a dynamic and complex activity. In all services, irrespective of industry sectors or types of customers, services are co-produced with and truly involving consumers. In support solutions, service engineering and system engineering are used together as critical knowledge agents to guide the solution design. Service engineering emphasizes customization of solution designs to meet service needs, while system engineering emphasizes technical performance of the solution [11].

SSE framework is consists of 3 elements (People, Process and Product) in an operation environment. Also, it contains three levels structure (Execution, Management and Enterprise) [12]. The SSE framework model called 3PE model as shown in Fig. 1.

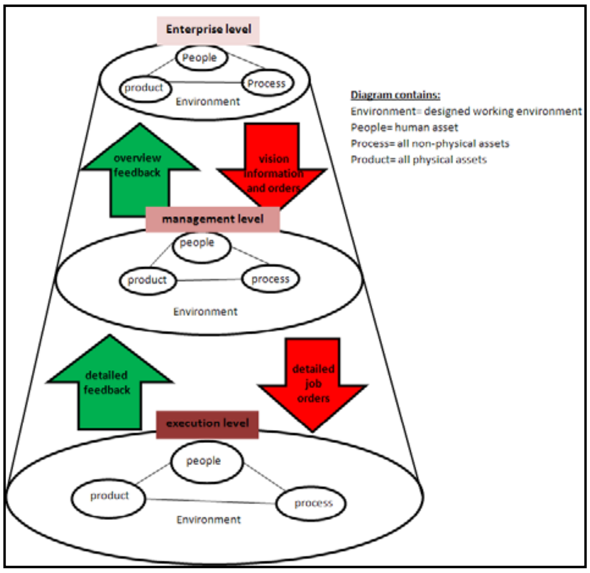

Fig. 1 General vision of system support engineering generic framework (multi-levels 3PE)

3PE model is used to structure and calculate performance for asset management system, as the whole idea of the support system engineering is to sustain the performance of the operating asset.

The benefit of the system support engineering model in relation to the performance measurements of asset management system are:

a) The performance elements in the asset management system are independently measurable.
b) The measures are meaningful to people who use them by capturing a dimension of their performance in a way that they can understand.
c) The measures are continually evaluated in reference to the organization short and long term goals.

The measurement method will depending on the measured element where the most suitable and accurate method will be performed on the element and then later on all the results will be collected together to have overall system performance analysis in order to measure the system overall performance. This process may sound very lengthy but its effective and the process will become faster as the practice continued and the information start to cumulate.

The ability of measuring performance is to compare it to a set performance standard [13]. Depending on the complexity introduced by the management, the contract payment terms can be described as a function of performance.

III. Performance Evaluation of Asset Management System

Performance measurement practices have undergone many innovations [14]. Lots of these innovations are toward systemic approach [15], [16]. The main challenge in this research is to produce a methodology to build and present the structure performance calculation. Talking to a range of professionals in the field, nearly all of them recommended a hierarchy build up format. They did not know the details but they thought it is the best if it can be achieved and easier for them to use and understand. Moreover, the input could be straightforwardly distributed to multi management levels. In addition, literatures overview showed that the advantage of build-up methodology is reducing the amount of error or the error contribution to the final score in calculation. Therefore, the structure of performance calculation was drawn as hierarchy structure (see Fig. 2) so it will be easier to follow and include additions.

The second challenge was to formulate an equation to accommodate the elements in a simple format, keeping in mind the interaction and interface between the elements evaluated in the SSE frame work. Moreover, this formula should be generalized to all asset management systems and could be applied to different level of management which is a huge difficulty by itself. After long surveying and reviewing performance measurement systems available in the literature, (1) was proposed.

$$P = \alpha X + \beta Y + \gamma Z \qquad (1)$$

where:

- P is Achieved performance, People (X), Process (Y), Product (Z).
- α, β and γ are the weights or the factors and in some cases is the value of the element in the system which extracted from the interface and interaction evaluation.
- $1 = \alpha + \beta + \gamma$.
- X, Y and Z are the performance scored based on the KPI's calculated.

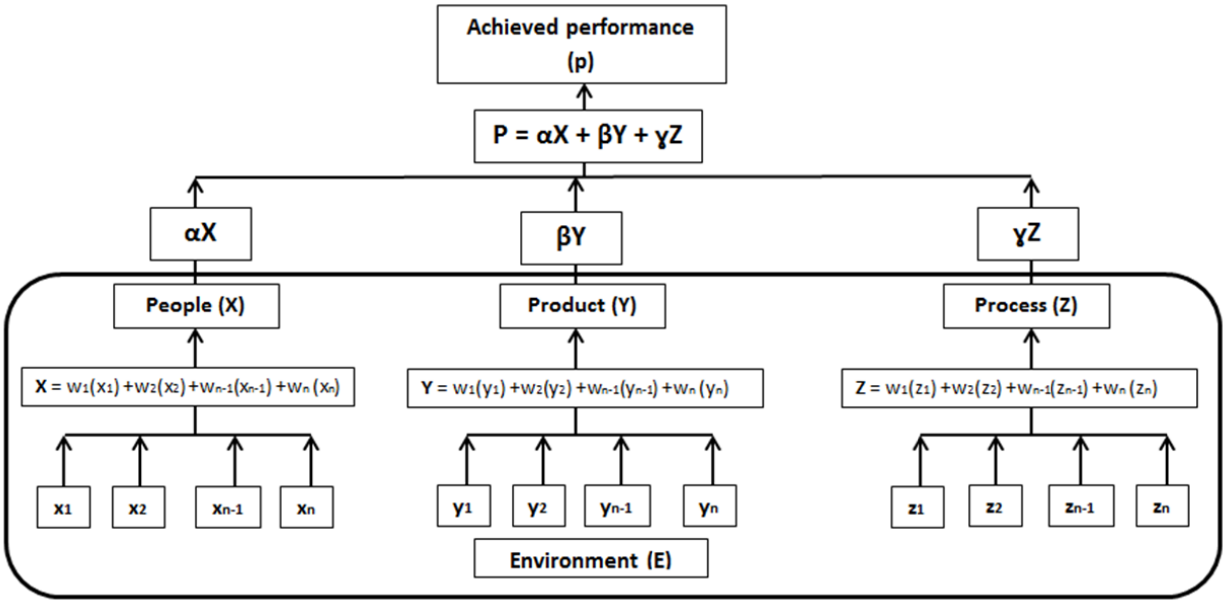

Fig. 2 Performance evaluation and calculation outlines based on 3PE model

where:

- α, β and γ are the weights or the factors and in some cases is the value of the element in the system.
- $1 = \alpha + \beta + \gamma$
- X, Y and Z are the performance scored based on the KPI's calculated.
- x_n, y_n and z_n are the KPI score for that element.
- w_n is the contrition weight of that element or the KPI score.
- $1 = w_1 + w_2 + w_{n-1} + w_n$
- E is the environment where all this elements are performing. Environment will have an effect or an impact on the performance of these elements. The environment factor could be included in KPI score marking.

The next stage was to study and develop a methodology to evaluate the performance of each element (X, Y, Z). After long literature and industrial investigation it has been found that the elements need to be categories in order to be evaluated.

The generic detailed elements in order to calculate the factor "People (X)" is presented in Fig. 3

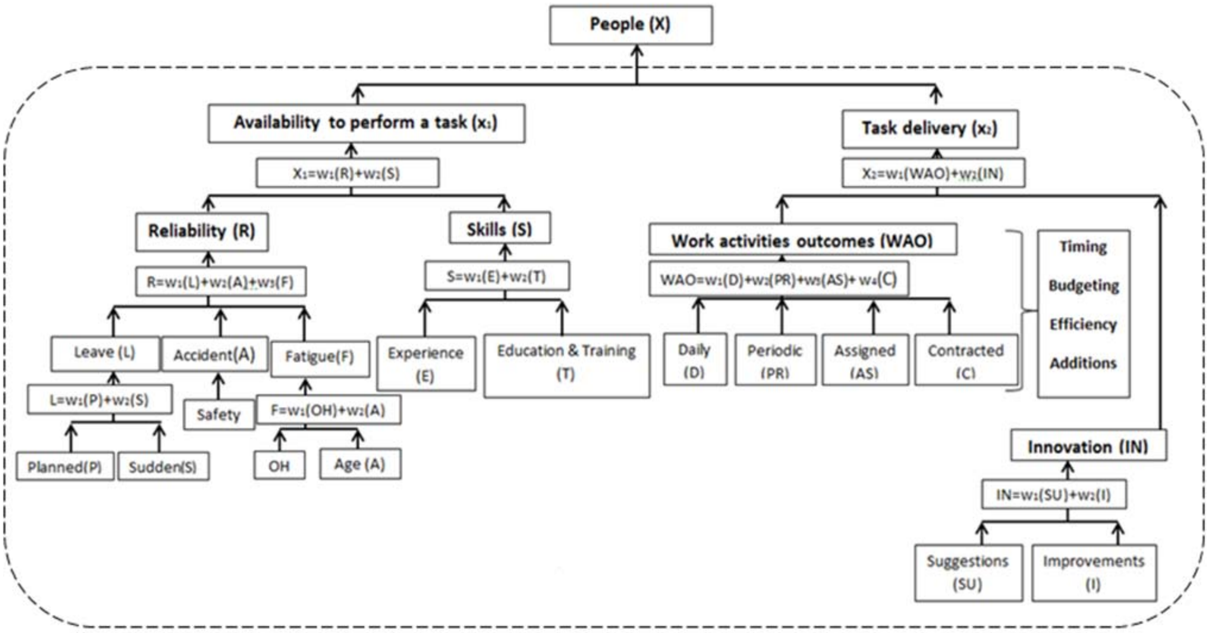

Fig. 3 Performance scoring and calculation outlines for people (“X” factor)

where “wn” is evaluated and distributed in each level separately from other levels but cumulative distribution weight for the calculated element or the interface effect between two elements, as $1 = w_1 + w_2 + w_{n-1} + w_n$

The generic detailed elements in order to calculate the factor “Process (Y)” is presented in Fig. 4.

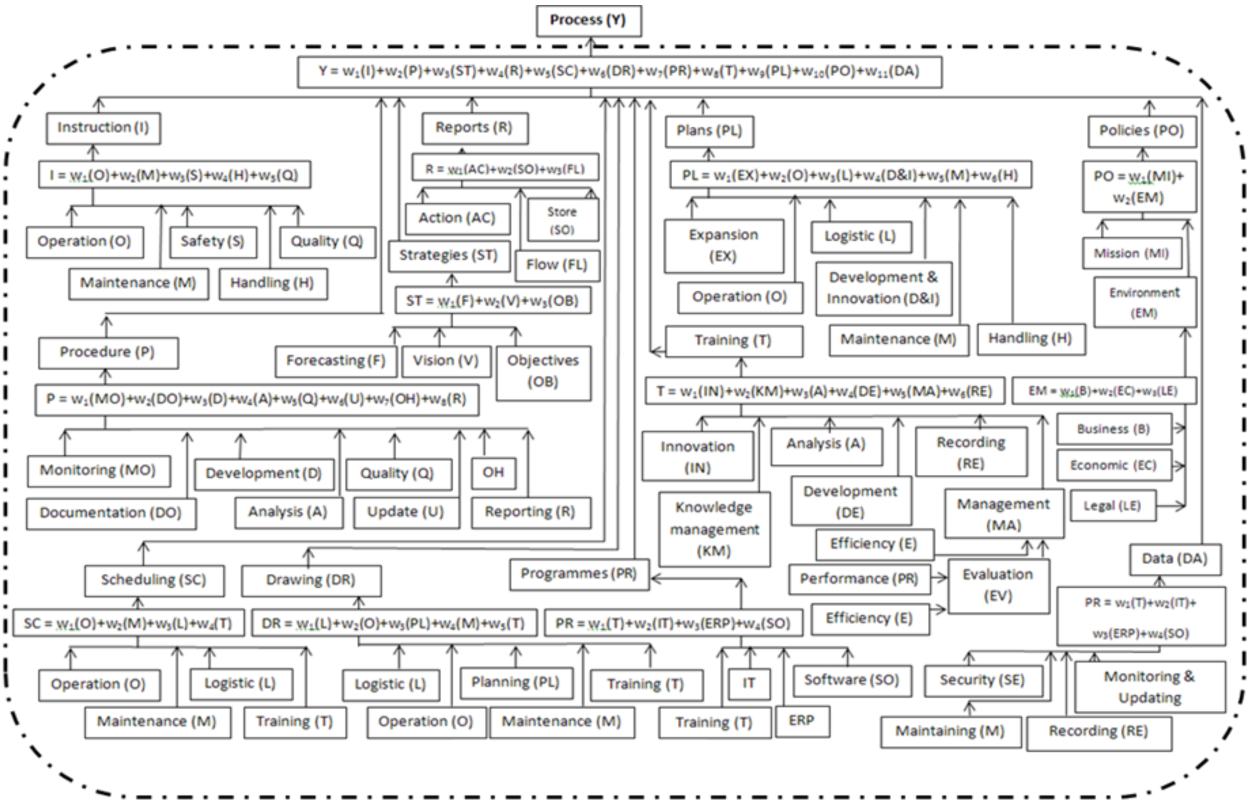

Fig. 4 Performance scoring and calculation outlines for process (“Y” factor)

where "wn" is evaluated and distributed in each level separately from other levels but cumulative distribution weight for the calculated element or the interface effect between two elements, as $1 = w_1 + w_2 + w_{n-1} + w_n$

Same-wise, the generic detailed elements in order to calculate the factor "Product (Z)" is presented in Fig. 5.

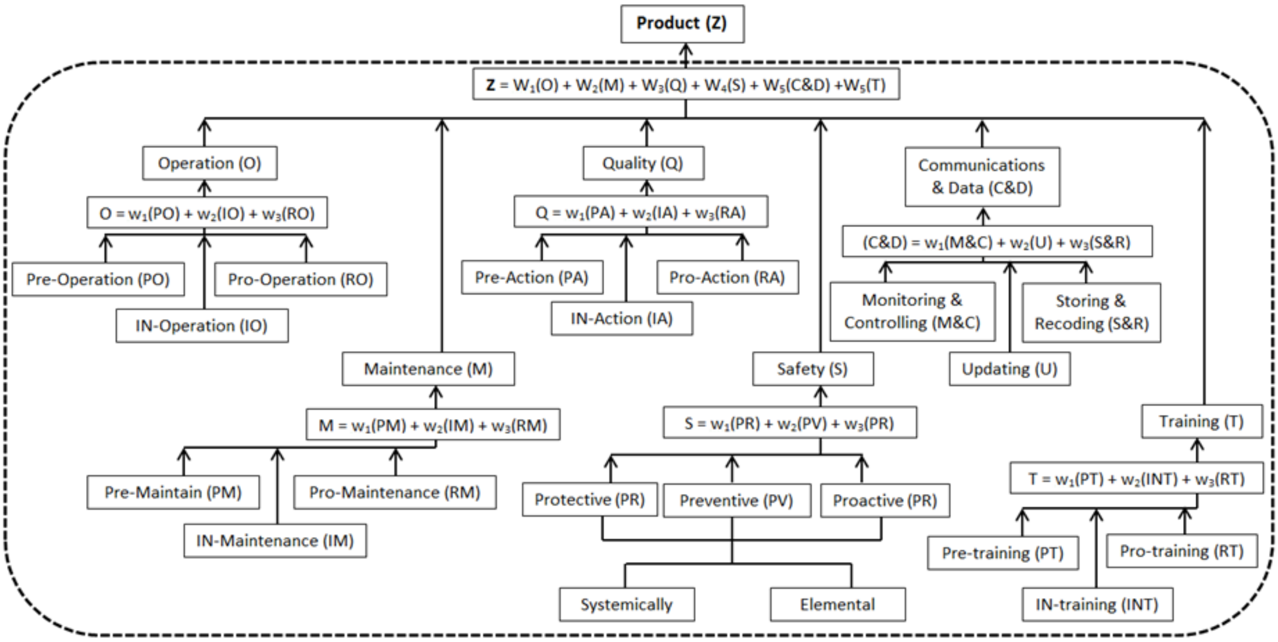

Fig. 5 Performance scoring and calculation outlines for product ("Z" factor)

These structures of performance calculation gave the ability to estimate the risks could be associated with each element and the service provided to it. This risk could be identified based on the work environment analysis. Therefore, the first step in the risk identification is to define the work or operation environment and in some cases even the business environment. This analysis is guided by the risk analysis process in SSE model.

IV. Conclusion

The paper presented an approach to evaluate the performance of an asset management system. This paper briefly discussed the attempt to induct a structure to evaluate the performance of an asset management system. Based on the SSE framework, this paper provides a detail approach to estimate the performance. The research suggested that this could be a useful tool or techniques that practitioners in the industry can apply to help them in service design for operating assets in order to maintain optimized performance. The difference in developing this technique is that it has been inducted from the industry and Allow for interpolation from professionals in the system to describe their practical understanding and thinking. Therefore, it becomes easier to be implemented or used by the practitioners and this could be the main advantage from the preceding research work in this area. The findings suggested that further investigation need to be carried out. The aim of this investigation is to detail the effect(s) of operation environment on the 3P elements in regard to their performance in asset management system. Never the less, the effects of the interface and/or interaction between the 3P elements should be taking into account in this investigation as well.

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