TOWARDS A GENERIC FRAMEWORK FOR WHOLE LIFE COSTING IN THE OIL INDUSTRY

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There have been a number of endeavours to establish and implement the whole life costing (WLC) technique in several industries. Many researchers recognize that the lack of readily available WLC data constitutes the most important barrier that inhibits its successful practical implementation. Data breakdown structure plays, therefore, an important role in promoting the adoption of WLC. These arguments are especially true for oil and gas assets in which operation, maintenance and support activities represent the bulk of their whole life costs. This paper focuses on addressing this limitation by discussing the suitability of incorporating integrated logistics support (ILS) with WLC. This Paper is first in a series to report an on-going PhD project to develop a generic framework for whole life costing applications in the oil industry. The main issues inherent to the development of this framework have been considered. Firstly, a literature review covering the WLC and ILS techniques are carried out. Then, the necessity of including these techniques into current oil and gas asset management practice is discussed. Finally, directions for future research are introduced.

Keywords: cost breakdown structure, integrated logistics support, oil and gas assets, whole life costing.

INTRODUCTION

There is a growing awareness that whole life costing (WLC) techniques offer benefits in assessing costs of projects, facilities and equipments before commitment is made. Within oil industry, there has been a Joint Industry Project (JIP) formed by some major oil companies to develop a common and consistent WLC methodology especially for the industry (Vorarat *et al.*, 2000 and Crabb, 1995). Thus, it seems that the oil companies are going to gain more in term of competitiveness by adopting the whole life costing approach. The current status that WLC is not use is mostly due to the practical difficulty in applying it effectively. Varying from data collection to the fact that WLC is not well known among asset managers. This situation sets the challenge of determining what action is appropriate to seek to spread the benefits of WLC and to overcome the common barriers to the WLC adoption. On the other hand, since oil asset management depends largely on maintenance and logistics activities in keeping equipment available and operational at the lowest costs (ISO TC/SC N, 2005), the logistics support can be regarded as an important part of WLC implementation. It helps to determine the optimum maintenance strategy by answering questions like (Lashbrooke and Stratton, 1996): what spares should be available in time and in place for repairing and maintenance activities? Establishing an approach

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to the adoption of WLC by providing a systematic data collection model and determining the best practice of the logistics support for the WLC purposes, the oil companies will improve significantly its performances and its competitiveness.

In addition, the general characteristic of petroleum equipment is that they are very expensive not only at the acquisition stage but also at the running stage. Kawauchi and Rausand (1999) pointed out that the average ratio between running cost and the whole life cost within oil and chemical process equipments varies from 60 to 80%. For instance, a gas turbine driven generator with a purchase cost of US$ 10 million, maintenance cost of US$ 0,5 million per year and fuel cost of US$ 5 million per year, its whole life cost for a period of 20 years and 15% discount rate is about US$ 44,3 million. The contribution of purchase cost in whole life cost is approximately 23% (Riberio *et al.*, 1995). Therefore, taking into account the initial acquisition cost alone is unsatisfactory, some consideration must also be given to costs which will accrue throughout the equipment life. Thus, this witnesses the significance of the use of WLC for monitoring these equipments; where initial and future costs are both considered in WLC decisions.

Moreover, oil assets are requested to operate in remote areas with mobile support units which put the requirement of flexible and easy maintenance tasks. The managers of this kind of assets are always seeking for both operational performance and cost effectiveness. Hence, the integrated logistics support (ILS) represents a support ensuring the operational phases and a mean leading to a full availability of an asset with the lowest costs (Dodds *et al.*, 1989).

The objective of the research work that underpins this paper is to identify how ILS can be integrated with WLC to develop a generic framework for whole life costing in the oil industry.

WHOLE LIFE COSTING (WLC)

Whole life costing (WLC) is a technique which enables comparative cost assessments to be made over a specific period of time, where all relevant economic factors both in terms of initial capital costs and future operational costs are considered (as defined by BS 15686 of service life planning). This technique offers a valuable key to decisions involved in acquiring new systems. A meticulous investigation of acquisition costs, through-life costs such as operation and support costs, maintenance and potential upgrading costs, and disposal costs, is carried out to achieve a cost-effectiveness approach in managing the new or existing systems.

The past decade has witnessed greater interest in WLC and many industries are responding with renewed commitment to promote WLC use by adopting standards and norms. Historically, WLC dates back to the 1960's when the US Department of Defence started to include cost view all over the product life to support managers in the acquisition of military assets (Blanchard, 1983; Glucha and Baumannb, 2003). At that time DOD officers discovered that operation and support costs for a weapons system represented for 75% or more of total costs and as a result they have been putting a growing importance on WLC to ensure a proper weighted in procurement decisions (Asiedu and Gu, 1998). Afterwards, WLC use extended to design phase to provide the DOD decision makers with comprehensive cost information on investment alternatives by comprising the total costs of production, operation, maintenance, support, and decommissioning.

DIFFICULTIES FACING WLC IMPLEMENTATION

The WLC procedure is, in theory, straightforward by considering alternatives, evaluating long-term costs and choosing the best option. However there are a number of difficulties may limit its widespread adoption by the industry. Many authors (Kishk *et al.*, 2005; and El Harem, *et al.* 2002a) claim that the WLC has not been given a much attention in practice, whereas its principles have been well developed in theory. The reason for this is that WLC has several major weaknesses. The lack of readily available WLC data constitutes the most important barrier that inhibits the successful WLC application in the industry (Glucha and Baumannb, 2003). Carrying out a WLC calculus is a data intensive process due to the complexity of the systems and their various components. The final WLC output is, therefore, dependent on the accessible and reliable input data (Stener, 2000). Furthermore it is relatively easy to establish an estimate the acquisition cost of an item, it is far more difficult to measure the operation and maintenance cost that is likely to be incurred after purchasing. Al-Hajj (1991) revealed that WLC application is caught in a vicious circle containing a series of causes and consequences (Figure 1).

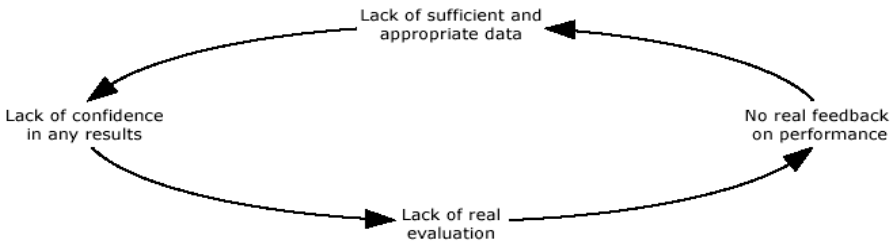

Figure 1: The vicious circle of WLC implementation (AL-Hajj, 1991)

The lack of real evaluation of existing assets implies no real feedback on their performance is carried back to the design stage of similar assets. A lack of sufficient and appropriate data is therefore inevitable. Consequently, the WLC results as an information provider for decision making could be doubtful and not inclusive. This serious lack of confidence in any WLC calculation is one of the reasons behind the limited use of WLC despite the long history and potential advantages according to Shields and Young (1991) and Artto (1994). The main problem pointed out by Flanagan (1989) is the need to estimate over a long period of time factors such as life cycles, future operating and maintenance costs and dealing with uncertainty may have restricted its use.

To improve WLC implementation, this circle should be broken somewhere. This can be done by employing mathematical models to handle data uncertainties. Alternatively and perhaps more practically, actual operating and maintenance costs of existing assets are collated and related to performance data. To do so, a cost breakdown structure (CBS) is crucial. A CBS should be designed to allow different levels of data within various cost categories and to provide a considerable detail to each option costs which are generally obtained by referring to historic data of similar project, by estimating or by expert judgement (Kirk and Dell'Isola, 1995).

There have been a number of endeavours to overcome this barrier by adopting several cost breakdown structures (CBSs) to improve data collection, recording and to identify all the relevant cost elements in all life cycle phases. Examples in the framework of the construction industry include El-harem *et al.* (2002a, 2002b) and Kishk *et al.* (2005), among others.

Within the oil industry, Grabb (1993) claims that even though the WLC technique is applied by individual operators on their own development studies, it needs to be universal for all firms operating in oil industry. As result, some of oil companies have created a JIP (joint industry project) to establish a common WLC methodology inherent to oil and gas industry. Grabb (1995) enumerated a number of benefits achievable once the WLC is implemented. For instance, operators, contractors and vendors can use the WLC criteria to measure business performance form which business transactions can be managed. Consequently, oil industry actors have been looking at adopting a common procedure that allows considering while life cost and performance data during acquisition through the asset's life.

The other feature intrinsic of the WLC use in oil industry is that it is closely linked to system reliability, availability and maintainability (RAM), than in other industries (Kawauchi and Rausand, 1999). Integrated logistics support (ILS) is a management system that includes these reliability techniques and permits performance data and cost issues to be related. The usefulness of ILS in this regard is discussed in more detail in the following section.

INTEGRATED LOGISTICS SUPPORT (ILS)

Increasing attention to the cost of system maintenance and operation is driving efforts towards considering optimum readiness, including reliability, availability, maintainability and supportability (RAMS), when ranking alternatives for investment or construction. Consequently, the industry requirements are no longer concentrated acquisition costs but have been enlarged to comprise whole life cost, supportability, maintainability and reliability of systems. All these elements are grouped under one management approach named integrated logistics support (ILS). Similarly to some management approaches, ILS was initiated by US Department of Defence around 1970 in order to control the cost of both acquisition and support of complex systems. The use of ILS has been mainly in the military field. Notwithstanding this, the concept of ILS is being adapted to meet the requirements of procurement and support systems within civilian systems which have support requirements (Blanchard, 1983).

Integrated Logistic Support is considered as "the spectrum of all activities related to the logistic support during the entire life cycle of the technical system. These supportability activities refer to maintenance concept development, spare parts provisioning, technical information collection, maintenance crew selection, training, etc" (Waeyenbergh and Pintelon, 2002). Furthermore, the supportability activities generally are split into two primary tasks. The first task consists of design stage development in which user's operation and maintenance requirement needs are met. However the second task involves implementing the support program that most effectively utilizes the user's available and operating assets. Consequently, one of the major benefits of this approach is that the operational cost of the systems would be identified earlier in the project and optimized for minimum through life cost (Pretorius, 2003). Many other researchers (Asiedu *et al.*, 1998; Baros *et al.*, 2000; and Dinesh Kumar *et al.*, 1998) claim that logistics support is an important item in ensuring that all support activities are justified, planned, acquired, tested and supplied in a timely and cost-effective way.

The integrated logistics support (ILS) being used in many industries to successfully improve database provision, spares parts planning, maintenance strategies and to support activities leading to high equipment availability and maintainability (Figure 2). Within ILS elements, two particular techniques FEMA and RCM have achieved a major maintenance cost reduction (El-Harem, *et al.*, 2002b). FEMA technique focuses on identifying failures occurrence and their potential effects and RCM technique offers the cost effective maintenance approach. The use of these techniques will provide data about failures and maintenance costs that are not available in the industry.

Like the defence sector, the costs of a project can be significantly reduced over the life of a project by using integrated logistics support (ILS). The Ministry of Defence (MOD) reports savings of over 25% by considering support at the design stages of a project (Rhys-Haden, 1998). Combining ILS and WLC techniques looks attractive for other industries (such as construction) (El-harem *et al.*, 2002 b).

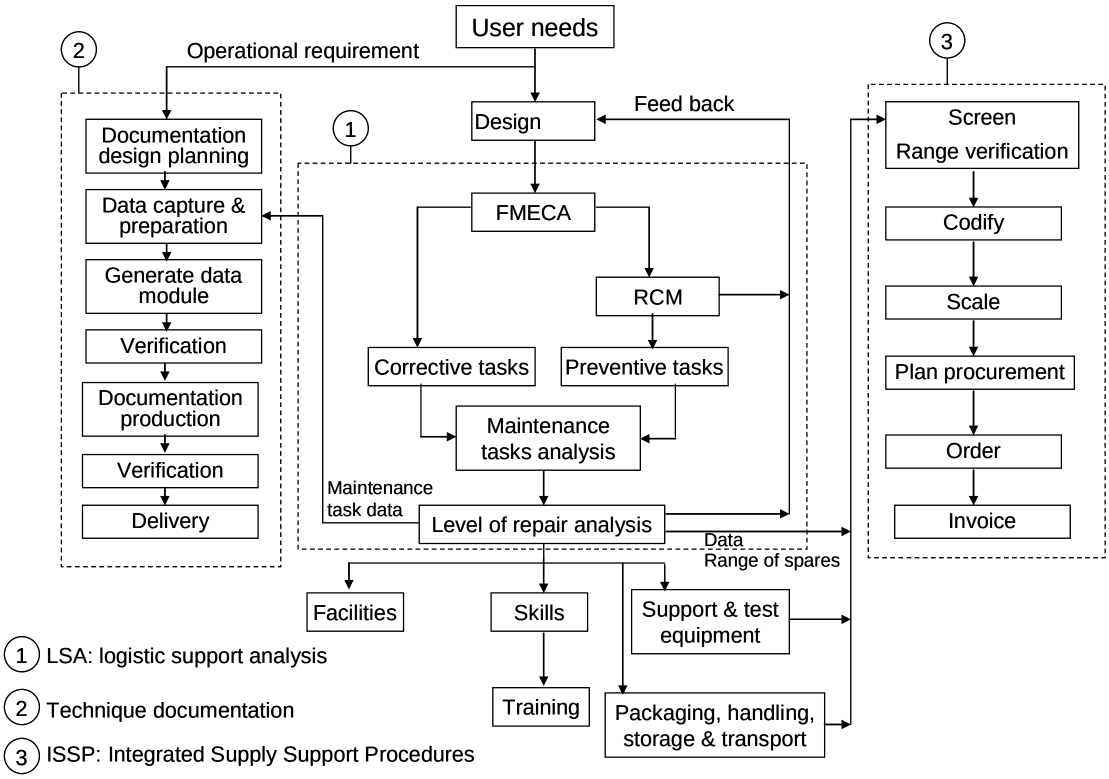

Figure 2: ILS Process Diagram (UK Defence Standard 00-60, 2004)

As illustrated in the above Figure, reliability engineering is the core of the logistic support analysis (LSA) process. Failure modes, effect and criticality analysis (FMECA) focuses on significant items to determine if effective maintenance task can be planned to maintain the function of the item. However, reliability Centred Maintenance (RCM) is designed to minimize maintenance costs by balancing the higher cost of corrective maintenance against the cost of preventive maintenance, taking into account the loss of potential life. Both of FMECA and RCM is defined as part of the LSA exercise and, by implication, should use the data held within the LSA record (LSAR) database. Therefore, LSAR provides the documentation of detailed engineering and logistics support requirements data produced by the LSA process. Furthermore, the defence standard pays a great attention to LSAR by prescribing standard requirements, data record formats, data element definitions, and LSAR reports.

INTEGRATING ILS AND WHOLE-LIFE COSTING

WLC techniques include other managerial tools that help users to incorporate holistic perspectives into the decision making process. One such technique, integrated logistics support ILS, provides valuable information on inputs, operation management and outputs of a defined system throughout its entire life cycle from the conception to the final disposal.

Ford-Chafee, (1994) states that the cost estimation for WLC purposes falls into three categories: parametric estimation, comparative estimation and engineering estimation. He considered the last technique more accurate because it provides detailed, in-depth cost analysis of a well defined system. Within this technique, a simulation is performed on system performance for various design options to obtain a trade-off analysis of cost versus specific design performances. Individual cost drivers are identified and related to performance and supportability objectives. Consequently, WLC results should balance the whole life cost of systems with its technical requirements (Figure 3). Furthermore the WLC offers the ability to evaluate initial capital costs against the cost to operate and support the system over its operational life. In addition, Stavenuite has represented ILS as a separate process supporting the primary process corresponding to all life cycle (Figure 4). This will enable support considerations to influence system design and selection.

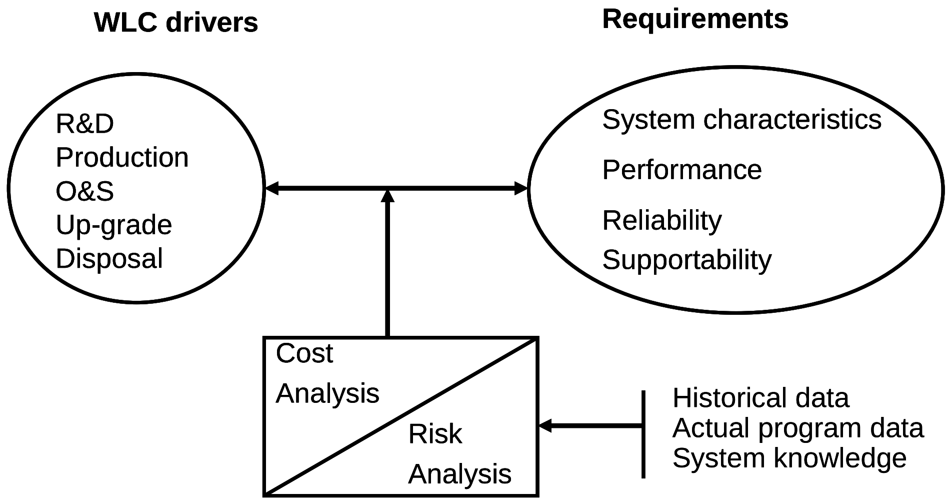

Figure 3: Fundamental requirements of life cycle costing (Ford-Chafee, 1994)

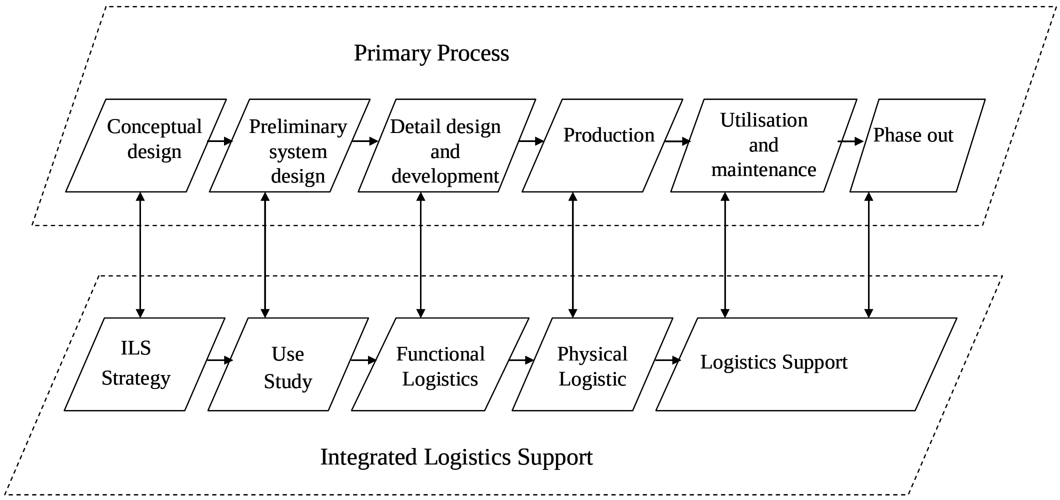

Figure 4 : The ILS phases related to whole life cycle of a system (Stavenuite, 2002)

The current emphasis on ILS is reflected by tailoring the LSA process and its documentation requirements on a WLC framework. The later will offer a direct correlation of engineering and performance data into WLC modelling. Besides, this framework could develop a technique to accumulate and translate the various input data sets into WLC data formats.

CONCLUSION AND THE WAY FORWARD

There are many obstacles facing the practical implementation of WLC, foremost regarding the availability of the required data. There are two features intrinsic of the implementation of WLC in oil industry. The first is the increased inclination to adopt universal data structures. The second is the relative importance of systems' reliability, availability and maintainability compared to other industries. Therefore, it seems logical to employ the techniques of ILS to develop a generic framework for WLC applications within the oil industry. The operation and maintenance activities will be divided into physical elements and functional models by tailoring ILS techniques to petroleum assets. These models establish the relationship between the functional breakdown and physical elements that make up petroleum assets.

Opportunities for reduced support costs and more effective support are based on the systematic capture and reuse of all information throughout the equipment life cycle. The development of the anticipated framework entails the building of a process activity model and an information model. Two novel process and information models are being developed and will be reported in two future papers

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