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EMERGENCE OF RISK-BASED INSPECTION AND MAINTENANCE AS AN ALTERNATIVE MAINTENANCE APPROACH FOR OIL AND GAS FACILITIES

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Abstract
An oil and gas plant is a complex system comprising various types of processing equipment consisting of mechanical, electrical, chemical and civil systems working under extreme conditions. The systems suffer increased wear with usage and age and are subject to random failures that are linked to the deterioration of these assets. A single or peculiar maintenance strategy may not serve the maintenance needs of this complex system. Hence, various maintenance approaches have to be tested and adopted for a particular cluster of systems or sub-systems. The general objective of the maintenance process is to make use of the knowledge of failures and accidents to achieve safety with the lowest possible cost. Bearing this philosophy in mind, Risk-based inspection has emerged as an alternative approach to time-based planned maintenance, condition-based proactive maintenance, and prediction-based preventive maintenance. These popular and historically long approaches were found to be practically unfit to contemporary competitive markets due to the tendencies of under or over inspection which may consequently lead to under of over allocation of maintenance resources on the one hand and under scoring of other social impacts of the plants and its system on the other hand. Therefore, this paper intends to review the philosophy, concept and types of Risk-based maintenance and its anticipated promises to civil structures in oil and gas facilities.

Keywords: Oil and Gas Plant ,Risk-Based Maintenance, Risk-Based Inspection

1. Introduction

Economic depression, environmental laws, safety and health standards and other demands are deemed to be among the factors shaping the global direction. These factors are eminent in the oil and gas industries and are believed to be catalyst for change in the management of facilities both new and old worldwide (Telford, Mazhar, & Harwad, 2011). Moreover, the challenges of intense international competition and market globalization have placed enormous pressure on maintenance system to improve efficiency and reduce operational cost at the same time as posited by (Wan Mahmood, Ab Rahman, Mazli, & Deros, 2009). These challenges have forced maintenance managers to adopt tools, methods and concepts that could stimulate performance growth and minimize errors, and to utilize resources effectively towards making the organization a high performance plant. In the same direction, many companies are investigating the broader implementation of automation to reduce the number of employees required and the risk they are subjected to in a bid to improve efficiency and decrease human error and risk, although (Telford et al., 2011) observed, this approach resulted to a number of unmanned facilities particularly in remote location, a consequence that may result to increase in operation cost. However, according to (Hu, Cheng, Li, & Tang, 2009) maintenance cost tend to be very high accounting for approximately 20-50% of the total operating budget of process systems. Thus a balance has to be made between the frequency and extension of the maintenance on the one hand and cost on the other (Selvik & Aven, 2011). In an effort to strike the balance, (F. I. Khan & Haddara, 2003) opined that, maintenance management techniques have been through a major process of transformation from focusing on periodic overhauls to the adoption of condition centered, reliability-centered maintenance and expert system and most recently risk based maintenance methodologies started to emerge.

2. Evolutions In Maintenance Philosophy

With rapid technological development, maintenance approaches also continue to change from one approach to another in a bit to comply with the technological needs of the consumers. Today, the maintenance progress has been provoked by the increase in complexity in manufacturing processes and variety of products, growing awareness of the impact of maintenance on the environment and safety of personnel, the profitability of the business and quality of products (Arunraj & Maiti, 2007). Hence, maintenance have moved from the classical "fix it when it broke" to time based maintenance and subsequently to reliability based maintenance. More sophisticated Risk based maintenance approach emerged recently which considers the status of a system in terms of both technical and social functions. However, the approach is considered a new approach, but there are many studies conducted to explore its potentials in various engineering applications. Figure 1.2 shows stages of change in maintenance approaches.

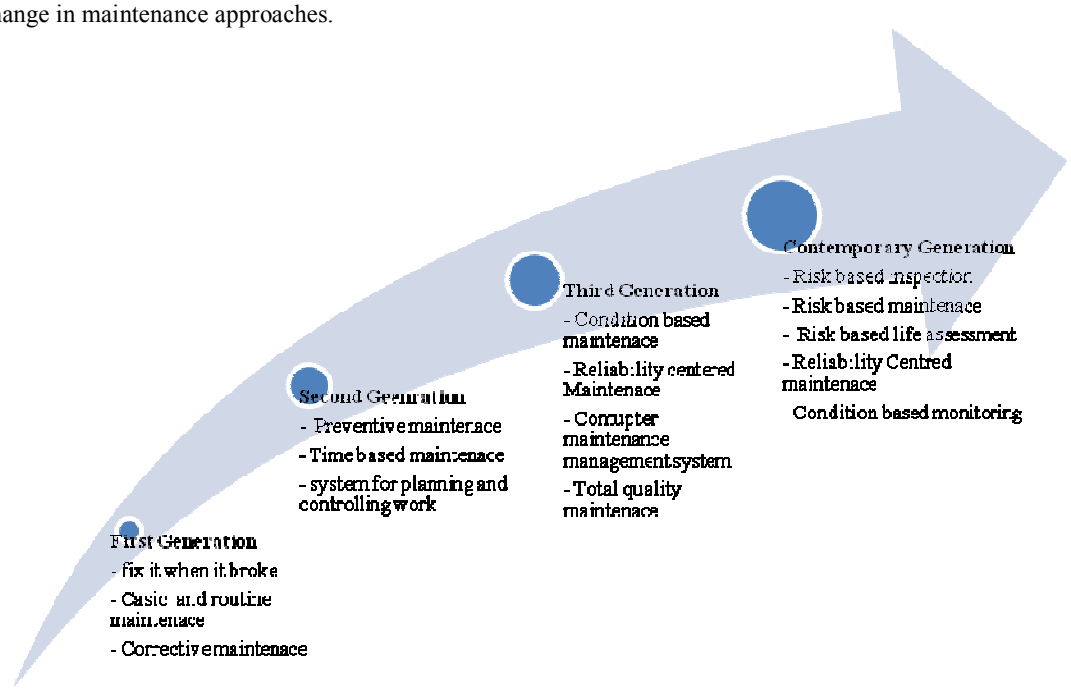

Figure 1. stages of development in maintenance approaches (Modified from (Arunraj & Maiti, 2007))

According to (Serratella, Wang, & Tikka, 2008) Risk based approach to maintenance was first identified in nuclear industry in 1970s, and over the years have diffused into other industries such as the downstream petrochemical and refining industries in 1980s and 1990s, Meanwhile, (Bertolini, Bevilacqua, Ciarapica, & Giacchetta, 2009) observed that, desire for the involvement of risk analysis has widened in progress over the last 30 years, when risk analysis appeared as a good as well as extensive method that remedies and also enhances the entire management of virtually all facets of our life. Operators of medical care, the environment, and physical facilities systems all integrate risk analysis within their decision-making procedure. Furthermore, this ubiquitous transformation of risk analysis by a lot of professions, along its implementation by industry and government departments in decision-making, currently have resulted to a remarkable growth of principles, methodology, and also practical methods for implementation of the approach in engineering system. (Marhavilas, Koulouriotis, & Gemeni, 2011). Therefore, development of risk based maintenance programme in oil and gas facilities will be a tremendous achievement shift in the way the assets are being managed.

2.1 The Risk Based Inspection and Maintenance

Risk-based inspection is one the strategic modem approach towards ensuring the integrity of engineering structures and components in a cost effective manner. The approach relies heavily on experience, insight and awareness of the likelihood of failure of components and prediction of consequence of the failure. According to (Arunraj & Maiti, 2007) the concept of Risk based maintenance was developed to inspect the high risk components usually with greater frequency and thoroughness and to maintain a greater manner, to achieve tolerable risk criteria. Therefore, understanding the mechanism of deterioration and failure of an item is very critical in achieving the defined objectives of risk based maintenance approach. In the same vein, the goal of inspection management plays a critical role in the process of managing reliability and performance of industrial plants,(Santos & Hajri, 2000). Moreover, the reasons for inspection according to (Peterson & Jablonski, 2003) are: maintaining the integrity of an asset, increase/maintain reliability, maintain a safe work place, ensure fitness

for service, provide and prove due diligence. Risk based adapts risk analysis to the process of inspecting damage and other forms of degradation in plants equipment (Reynolds, 2000).

According to (F. I. Khan, Sadiq, & Haddara, 2004)Risk based inspection and maintenance (RBIM) is a method for risk analysis and multi attribute decision making, which can be used in developing inspection and maintenance programme. Thus RBM can be used to identify critical components where inspection will provide most benefit in reducing the overall risk. Risk based inspection and maintenance are the well known methodologies for selection of proper maintenance strategies (Arunraj & Maiti, 2010). The methodology is designed to minimize the maintenance cost by balancing the high cost of corrective maintenance against the cost of other maintenance strategies. (Hu et al., 2009) lament that nearly 80% of the total risk is a process system is caused by 20% of equipment. Therefore the total risk can be reduced effectively by RBM strategy, which prioritized maintenance activities on the basis of quantified risk due to equipment failure. Usual the philosophy is that, high risk components/structures are maintained with greater frequency and thoroughness.

2.2 The Risk Based Inspection and Maintenance Procedures

Various literatures have different approach to Risk based methodology, earlier (F. I. Khan & Haddara, 2003) categorized RBIM process in to three modules, consisting of; *risk determination*, which consist risk identification and estimation, *risk evaluation* which consist of risk aversion and risk acceptance analysis and the third module which is maintenance planning considering risk factors. However, based on the additional works of (Arunraj & Maiti, 2007; F. I. Khan et al., 2004) Risk based maintenance is summarily comprises of two phases; risk assessment and maintenance planning. Risk assessment is also sub-categorized into hazard analysis, likelihood assessment, consequences assessment, risk estimation, risk acceptance and maintenance planning while (Hu et al., 2009) generalized that, risk-based inspection and maintenance to consist of subsystem identification, risk estimation, risk evaluation and maintenance planning. Meanwhile, (Selvik & Aven, 2011) maintained that risk-base maintenance can be described in three phases; Identification of maintenance significant items, assignment of suitable preventive maintenance task, implementation and update of the preventive maintenance task (Arunraj & Maiti, 2007) made synthesis of 25 *RBM* approaches, giving various techniques along with outlining the major negative aspects. The article on these techniques indicated that there's certainly no exclusive strategy to accomplish risk analysis and *risk-based* maintenance. The application of these techniques hugely relies on the degree within the analysis, area of usage and quality of final results. Therefore, a flexible analytical model which allows both qualitative and quantitative criteria to be incorporated in to the same decisions making methodology is required.

The general purpose of risk management in maintenance as postulated by (Kobbacy, Murthy, & Aven, 2008) is to ensure that adequate measures are taken to protect people, the environment and assets from harmful consequences of the activities being undertaken, as well as balancing different concerns, in particular risks and costs. Risk management consists of steps to prevent the occurrence of hazards and minimizing their possible damage. (Kobbacy et al., 2008)Usually risk management took it's origin from a *prescriptive* controlling strategy, by which thorough requirements are fixed towards the design plus procedure |for the} plans. This strategy has slowly has been substituted with a a lot more objective focused strategy, placing focus on what things to obtain as opposed to the remedies. As shown in many literatures, risk analysis is of two types the qualitative analysis and the quantitative analysis.

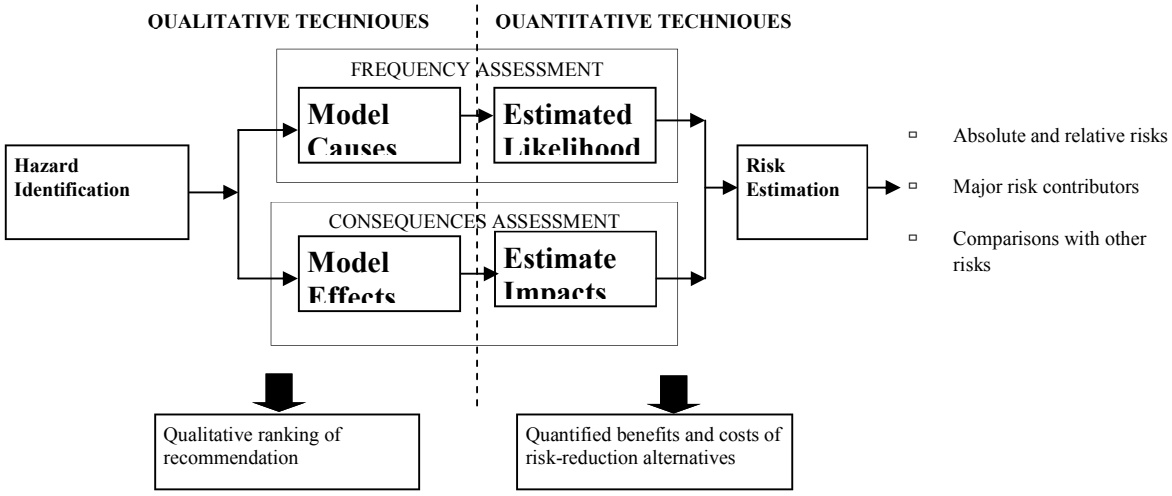

Figure 3 The Process of Risk Assessment {{59 Arunraj,N.S. 2007}}(Arunraj, 2007)

2.3 The prerequisite of Risk based maintenance in oil and gas

The most essential challenge within the Oil and Gas industrial sectors can be to accomplish a better measure of ease of use (availability) and reduce costs whereas protecting health safety and environmental issues in the operation of its installations (Ratnayake & Markeset, 2010). This requires a complete integration of maintenance and health and safety measures so that physical assets are designed and managed in a way that helps to protect their reliability through the entire life-cycle. Even so, often the changing demands from the physical assets and equipment over time have placed enormous challenges regarding maintenance in order to proactively fulfill the fast-changing demands in the production methods. Physical assets maintenance has gone by through considerable modifications in recent years. Thus, risk based maintenance will go a long way in considering both social and technical functional requirements as an integral part of asset integrity management

3. Conclusion

Increase competition in the global market has imposed extra challenges on oil and gas operators to ensure continues and effective supply to overcome any hindrance that may arise as a result of any failure. Furthermore, environmentally relating issues, particularly to oil sector are getting special attention across the world due to escalating awareness, government concerns, policy obligations as well as pressure from environmental activists. In spite of the extreme obligation, these companies are required to illustrate their own environmental protection commitments by the adoption of corporate environmental plans as well as proven efficiency within precise performance. Accordingly, components in the plants are getting older due to aging and other factors. Thus, there is a tendency of random failure which may be colossal in one hand and there need to maximize plant efficiency, reliability and product generation whilst minimizing manning and material cost, maintenance workload, downtime affecting revenue and maintaining contractual nomination as well as health and safety requirement and environmental standards in the other hand. Thus, this multi attribute challenges certainly require a systematic approach to maintenance policies and procedure such a risk based maintenance strategy.

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