A New Decision Making Model based on Factor Analysis (FA), F-ANP, and F-ARAS for Selecting and Ranking Maintenance Strategies

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ABSTRACT

Today, companies have admired that maintenance is a profitable commercial element. Therefore, its role in modern manufacturing systems has become more important. Maintenance plays a vital role in achieving organizational goals and improving indicators such as reliability, accessibility, decreasing equipment downtime, products quality, risk mitigation, productivity increase, equipment safety, etc. In this regard, maintenance and its strategies have found special importance in industry. As a result, the main aim of this research is to select the best maintenance strategy by using Fuzzy ARAS and Fuzzy ANP techniques in oil industry (Tehran Oil Refinery – Shahr-e-Ray). Since many variables (i.e. security, cost, added – value, etc.) are effective in selecting a maintenance strategy, these variables are initially identified by reviewing the relevant literature and maintenance experts’ opinions and then the best maintenance strategy is selected by using Fuzzy ARAS.

KEYWORDS

Factorial Analysis (FA), Fuzzy ANP, Fuzzy ARAS, Ranking, Repairs and Maintenance Strategies

1. INTRODUCTION

Today, due to technological development as well as industrial automation and increasing the number of industrial machines, the volume of investments by organizations in physical capitals and machineries are highly increased (Bevilacqua & Braglia, 2000). Since manufacturing industries are facing with hyper competition in existing global situation, it is highly important to have a production line with high productivity in order to mitigate the costs (Siew-hong & Kamaruddin, 2012). To achieve and guarantee long-term survival, manufacturing system should act more efficient, more effective and more economic and, in this line, they need proper maintenance. Some companies considered maintenance as an unavoidable cost source. For these companies, maintenance has a demolishing role and is conducted only in emergency conditions. However, such thinking is no longer acceptable due to important reasons such as quality in production, unit security and mitigating the costs of maintenance unit (between 15% and 75% of total costs depending on industry type) (Bevilacqua & Braglia, 2000). King (1990) said that the maintenance costs take up 6% of total sales revenue. In the design stage, maintenance costs are estimated to be 2-6% of capital costs. The maintenance cost consumes 15 to
70% of the total production cost (Ilangkumaran & Kumanan, 2012). Types of maintenance strategies that have the highest applications in thematic literature include: preventive maintenance (PM), condition based maintenance (CBM), predictive maintenance (PDM), total productive maintenance (TPM) and reliability centered maintenance (RCM). In this vein, corrective maintenance, preventive maintenance and condition based maintenance were the most common approaches in maintenance effective management (Gandhare & Akarte, 2012).

Since decision making and judgment on selecting maintenance strategies is usually complicated and unstructured which faced with multiple limitations and insights, the most important sub-measures are identified by 1st and 2nd confirmatory factor analyses and then maintenance strategies are rated by using multidimensional decision making techniques such as fuzzy ARAS and fuzzy ANP. In present study, it is attempted to help managers improve decision making process to select proper maintenance strategies by combining suitable tools. In this regard, a decision making structure is provided to select the best maintenance strategies by using relevant literature and tools.

Concerning above points, present paper attempts to answer the main question of the research namely what are proper maintenance strategies in studied industry and how they can be selected and rated by considering organizational goals as well as limitations and criteria which should be considered by organizational decision makers in selection process.

In this study, the literature was provided in the section 2 and the strategies of repair and maintenance in the study was introduced. In section 3, the study methodology and FA, FUZZY ANP and FUZZY ARAS methods as well as factorial analysis was used to prioritize criteria and sub-criteria. The strategies of repair and maintenance was done using FUZZY ANP and the results obtained by combining FA, FUZZY ANP and FUZZY ARAS were discussed. In section 4, the case study and final ranking of the strategies of repair and maintenance was expressed using FUZZY ARAS. In section 5, conclusion and proposed applications and the limitation of the study is provided.

2. LITERATURE REVIEW

2.1. Maintenance Strategies

2.1.1. Corrective Maintenance (CM)

It is also called as maintenance based on error, disabling maintenance or use-to-out of order maintenance. It is the main maintenance strategy used in industry (Waeyenbergh & Pintelon, 2002). In this strategy, the equipment is allowed to be faced with error before repair. The main attribute of corrective maintenance is that maintenance activities are performed when the machine is broken and no maintenance is done before error (Bevilacqua & Braglia, 2000). Overall, this strategy is executable in companies with high margin and is highly appropriate for trivial equipment or those ones which can be easily repaired (organization of the petroleum exporting countries, 2013).

2.1.2. Preventive Maintenance (PM)

It is also called reliability centered maintenance and scheduled maintenance strategy. Preventive maintenance is to use planned visits, regulating, repairing and replacing in equipment or factory. Preventive maintenance makes it possible to plan and schedule repairing works without any stop in production planning and improving equipment accessibility. The main activities in preventive maintenance include regular visits, preventive replacements and assessments (Shyjith, Ilagkumaran & Kumanan, 2008). In this approach, maintenance engineers can analyze equipment behavior by components’ reliability traits and pre-determine maintenance schedule and periodical repairs in order to prevent any error. It emphasizes on error prevention through maintenance in certain periods and assumes that the lifecycle of machine parts is predictable. It is a proper approach to mitigate reworks namely corruptions with a fixed rate. In this strategy, replacement and repairs are done after installing the equipment in a fixed time (Bevilacqua & Braglia, 2000).
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