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A novel quantified procedure for Failure Mode and Effects Analysis

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***Abstract*—This study proposes a new method for performing failure mode and effects analysis called Amended Failure Mode and Effects Analysis (AFMEA) based on quantitative data rather than relying on expertise, and employs the cost of various failures in order to make more accurate and cost-oriented decisions for preventive maintenance actions. Considering different failure expenses, dependability of parameters, and replication of failure causes in the new method, we put forward new formulations for calculating three main components of risk priority number (RPN). Propounding a case study from an automotive supplier, we compare the results of the traditional FMEA with the new outcomes in order to gain some experience with the modified method and analyze its usefulness. The performance of AFMEA will then be discussed and evaluated with datasets in three different periods using receiver-operating characteristics (ROC) curves. The result shows the superiority of Amended FMEA in contrast with the traditional FMEA.**

Keywords- Failure Mode and Effects Analysis (FMEA), Maintenance Management, Costs, ROC Analysis

I. INTRODUCTION

Reliability Centered Maintenance (RCM) is known as one of the most robust attitudes adopted for managing reliability, which was developed over a period of thirty years [23]. One of the principal milestones in its development was the report commissioned by the United States Department of Defense from United Airlines [24, 17, 18] and prepared in order to provide a comprehensive description of the development and application of RCM by the civil aviation industry [5, 28]. RCM is a process used to determine the maintenance requirements of any physical asset in its operating context. In other words, RCM is "processes used to determine what must be done to ensure that any physical asset continues to do whatever its users want it to do in its present operating context" [23]. It is an organized methodology employed to highlight the preventive maintenance tasks necessary to realize the inherent reliability of an item, considering the minimum resource expenditure [11].

RCM analysis principally provides a structured framework for analyzing the functions and potential failures of physical assets in order to develop a scheduled maintenance plan that will provide an acceptable level of operability, with a satisfactory level of risk, in a well-organized and cost-effective manner. RCM consists of seven major steps. Figure 1 indicates an overview of these steps and represents the impressive role of FMEA within RCM [26]. In the initial step, the equipment is selected to analyze. The next four steps, known as Failure mode and effects analysis, consist of determining the functions, describing the failures, specifying failure modes, failure effects description, and selecting appropriate maintenance or engineering actions by means of RCM logic. Failure modes are the possible ways and/or modes in which an asset can fail. Effects analysis comprises foreseeing the consequences of each failure mode [13].

A. Failure mode and effects analysis

Developed in 1949 by the American Army for evaluating the impact of system and equipment failures on mission success and the safety of personnel and equipment [32], Failure mode and effects analysis (FMEA) has been frequently used as a source for

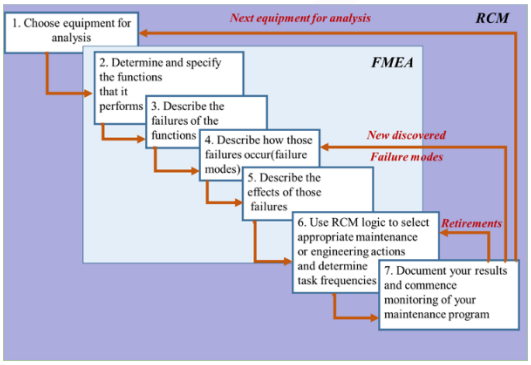

Figure 1: RCM process overview and FMEA as part of the RCM process