Application of RAM Concepts in Industries: A Critical Literature Review

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***Abstract*: The paper deals with Reliability, Availability and Maintainability analysis in industries and provides the significant information about the application of RAM concepts in industries. With advancement of science and technology and ever increasing needs of society, the applications of automation is necessity of every industrial system, thereby increasing complexities of industrial systems day-by-day. The products should also provide satisfactory performance with minimum failures during the useful life of products. Therefore, Reliability Engineering emerges as important field, which can provide the answer to the probability of satisfactory performance, economical cost and minimum failures. RAM deals with systematic analysis of system's failures and their effect on system's performance. To streamline operations and maintenance, RAM is used as a very important tool. The performance analysis in terms of availability (which is function of reliability and maintainability) provides a quantitative assessment how different maintenance tasks would affect system's performance.**

***Index Terms*—**Reliability, Availability, Maintainability, Performance Analysis**.**

INTRODUCTION

With growth of science and technology and ever increasing needs of society, the applications of automation is necessity of every industrial system in today's era. The complexities of industrial systems increases day-by-day. With the Globalization of market have imposed challenges before the industries to achieve the target. The products should also provide satisfactory performance with minimum failures during the useful life of products. Therefore, Reliability Engineering emerges as important field, which can address the issues related to satisfactory performance, economical cost and minimum failures during the life of a product. RAM deals with systematic analysis of system's failures and their effect on system's performance. RAM concepts have become the focus of all industries in the present time. To streamline operations and maintenance, RAM is used as a very important tool in the process industries. In view of the above, a thorough analysis of RAM parameters is desirable to minimize the deleterious effect of system failures.

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Literature Review

The Reliability and Availability analysis of process industries can benefit them in terms of higher production and lower maintenance costs. The availability (which is function of both reliability and maintenance) of complex systems in an industry can be enhanced by considering maintenance, inspection, repairs and replacements of the parts of the failed units.

Mokaddis and El-Said (1990) dealt with the availability function and the mean time to first failure for two models of a cold standby redundant system with two different types of repair. Both models were analyzed by the semi-Markov technique. Tewari et al. (1991) analyzed the reliability of a conveyor system. The various joint probability transforms were obtained by the use of Laplace transforms and the generating function technique. All the probability functions for determination of reliability of the conveyor system were determined on inversion of these transforms. Singh and Dayal (1992) considered a repairable system working in a fluctuating environment. The mathematically formulated problem was solved using the direct integration method. Expressions for the reliability function and mean time to system failure were derived out. Singh (1993) presented a single unit system operating in different environment. The expressions for system reliability, steady state availability and mean time to system failure were developed.

Sheut et al. (1994) recommended a decision model for corrective maintenance management. The model presented a comparative evaluation of alternative corrective maintenance policies. It predicted inventory costs and delivery performance of a corrective maintenance policy in various production systems. Kaushik and Singh (1994) discussed the reliability analysis of feed water system and naphtha fuel oil system in a thermal power plant. The expressions for

reliability, availability function and mean time to failure of the system were developed. Ashayeri et al. (1996) formulated a production and maintenance planning model for the process industry. They developed a mixed integer linear programming model to plan the preventive maintenance and production strategies simultaneously in a process industry. The scheduling of production and preventive maintenance jobs to minimize the costs associated with production, back orders, preventive and corrective maintenance was also suggested by this model.

Kumar et al. (1997) discussed the behaviour analysis of shell gasification and carbon recovery and desulphurization process in a fertilizer plant. The expression for steady state availability has been derived. Borgonovo et al. (2000) developed a Monte Carlo method for evaluating the plant maintenance strategies and operating procedures under economic constraints. The model offered a flexible tool to describe many relevant aspects of plant management and operations such as ageing, repair, renovation and obsolescence, not easily captured by analytical models. Bukowski (2001) presented a method for incorporating into Markov models the safety-critical systems, periodic inspections and repairs which occur deterministically with time. Based on this new modeling technique, solutions were derived for a variety of important performance indexes including MTTF, average availability and probability. Nakamura et al. (2001) described a maintenance schedule for pump systems in thermal power stations in order to reduce the maintenance cost during the whole period of operation, while keeping the current reliability level of the pump system. The dimensional reduction method was used to solve the problem. Tewari et al. (2003) framed out a decision support system for refining system with the help of mathematical modeling using probabilistic approach. A pay off matrix was developed which can help in determining the various availability levels along with the values of failure and repair rates. Arthur (2004) discussed the application of reliability centered maintenance to high speed, centrifugal dairy separation equipment. A pragmatic practical approach was demonstrated and the methodology employed in improving the equipment maintenance was fully described.

Chen and Trivedi (2005) built a Semi-Markov decision process for the maintenance policy optimization of condition-based preventive maintenance problems and presented the approach for joint optimization of inspection rate and maintenance policy. Kumar and Tyagi (2009) developed a mathematical model for exponential failure and general repairs. Expressions for various reliability parameters of the system were derived by the inversion process and computations were performed for the mean time to system failure and reliability of the system. Gupta et al. (2009) assessed the reliability and availability of a critical ash handling unit of a steam thermal power plant using the concept of performance modeling and analysis. Mathematical formulation for reliability of ash handling unit of plant has been carried out using probability theory and Markov birth-death process.

Tashtoush et al. (2010) developed a statistical model to evaluate the effect of corrective and preventive maintenance schemes on car performance in the presence of system failure where the scheduling objective is to minimize schedule duration. Kumar and Chaturvedi (2011) proposed a risk priority number approach which uses the predictive maintenance data clubbed with expert domain knowledge. Fuzzy sets and approximate reasoning were used to handle the uncertainty in data and subjectivity/vagueness of expert domain knowledge. The proposed approach was applied to a gearbox in a steel plant. Modgil et al. (2011) estimated the time dependent availability and steady state availability of ammonia cylinder manufacturing plant. The solution of differential equations was carried out using adaptive step-size control Runge-Kutta method. Khanduja et al. (2011) discussed the steady state behavior and maintenance planning of the bleaching system in a paper plant. The mathematical modeling was carried out on the basis of Markov birth-death process using a probabilistic approach. Garg and Sharma (2012) presented a technique for analyzing the behavior of an industrial unit. The synthesis unit of a urea plant situated in northern part of India has been considered to demonstrate the proposed approach.

Conclusions

The literature survey shows that various researchers works on reliability, availability and maintainability for various industries. Literature reveals that some work has also been carried out on RAM in various industries. But very limited work has been done in the area of application RAM with variable failure and repair parameters. In most of the paper work has been carried out, based on Markov modeling taking exponential distribution models. We intended to further analyze the various methods proposed so far. So, that we could suggest improvements in the existing models and various methodologies used to solve the RAM issues and parameters for various industries.

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