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Development of Methodology for Rams Analysis for a System

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Abstract
The RAMS belongs to the all facets of System Reliability, System Availability, System Maintainability, and System Supportability performance characteristics of an industrial system where the "industrial system" is a synonym for industrial plant, Manufacturing unit, Power plant, Coach factory, maintenance workshop etc. A successful RAMS analysis requires a systematic approach of data collection, development of database, RAMS models and interpretation of result. This paper deals with the development of RAMS based methodology to evaluate the performance of a system. The methodology has the four step, first is identification of data sources and data acquisition, second is the development of RAMS database, third is Method of RAMS analysis and the last is generation of system performance index.

Keywords: RAMS, Data Acquisition, System, Performance Index

1. Introduction

Analysis of system RAMS (Reliability, Availability, Maintainability, and Supportability) characteristics is a cost effective method to increase the profit from the industrial system. Designing an effective RAMS analysis program includes building of logical RAMS model of the industrial system, in the form of block diagram, event tree, Markov model or event tree, to highlight the areas which need improvements. There is many areas where the developed RAMS database can be used such as concept design, preliminary design, planning of various test, review of design, manufacturing processes, quality assurance, inspection levels, economic order quantity, management of inventory, logistic control and support, budgeting and field services [1]. In spite of this there are some particular uses of RAMS database are calculating hazard rate, repair rate, mean down time of an industrial system, lifecycle cost, decision making for redundancy, prediction of reliability, maintainability, availability of the system, planning for replacement, various design changes for improvement in RAMS, to carry out reliability vs. cost studies, determination of maintenance cost, carry out preventive vs. breakdown maintenance studies [2-4].

A successful RAMS analysis requires a systematic approach of data collection, development of database, RAMS models and interpretation of result. This paper deals with the development of RAMS based methodology to evaluate the performance of a system. The methodology has the four step, first is identification of data sources and data acquisition, second is the development of RAMS database, third is Method of RAMS analysis and the last is generation of system performance index.

2. Identification of Data Sources and Data Acquisition

The need for RAMS data generally continues long after system has been developed. RAMS data are necessary for lifecycle costing, evaluating warranty programs, computing spare parts inventory levels, determining the proper amount of maintenance resources, analyzing trends, identifying areas for engineering redesign and modification, establishing the proper level of preventive maintenance and overhaul programs, performing system effectiveness studies.

RAMS data may be obtained from sources within the organization and in many instances from external sources as well. The sources for collection failure data for an equipment life cycle are many. According to Reference [5] eight of them are below:

1) Claims against Warrantees.
2) Experience on identical or similar system.
3) Repair/Maintenance record.
4) Accelerated life and other factory tests.
5) All records of development phase (from concept to first proto type)
6) Customer's Complains or advise
7) All Tests carried out after the first proto type generation.

8) All Rejection due to quality checks

The data needed to support the RAMS analysis of a system fall in to three categories:

1. Technical and methodological data of the system under consideration for study, on the basis of which the RAMS model is created.
2. Historical/System operating data, which gives the ground for the development of RAMS models
3. Economical/cost data, which allow the economics of the perspective development concepts to be calculated.

Each of above mentioned classes of data is discussed below:

2.1 Technical and methodological data

Various type of technical and methodological information of a system is necessary for two reasons: primary, to define and create the RAMS model and secondary, to associate in determination of populations of the different parts present in a system and its subjection to hazards to calculate the failure rates could. With the help of technical and operating personnel on the system or developer or manufacturer of the system, the database development people collects the general modelling data as listed below:

1. Data for Configuration of the facility
   a) Assembly or configuration as per given drawing
   b) System line diagram (electrical and mechanical)
   c) Schematics of the system Instrumentation and control
   d) Block diagrams as per their logical arrangement
   e) Component list
2. System Methodological data, includes the kinds of procedures:
   a) Scheduled testing, b) Preventive maintenance c) Corrective maintenance

2.2 Historical/ system operating data

Following RAMS data are mainly required to quantify the RAMS Model:

The Historical data at system, sub- system or component level:

a) Identification of Component b) Failure Date, c) Details of Failure d) Repair/ Replacement action carried out, e) Repair Time, f) Support time, g) Maintenance personnel require, d) Spare parts needed

Other data may also be helpful in analysis:

a) Total Down Time, b) Failure cause, c) Failure mode, d) Failure Effect

2.3 Economical/cost data

Economical/cost data are required to develop the economical model of the system, which is under consideration. The developed model will be used to determine that whether the RAMS analysis investment is beneficial or not. The type of data needed for RAMS economic analysis is given below:

1. System specific cost data, includes the operation cost, maintenance cost, and cost spare parts and inventory cost etc.
2. The Market data which includes the pricing, marketing strategy, advertising of same system by other manufacture. It is the information which is hardest to collect and specify because each industry has some different specification and methods to settle in the market.

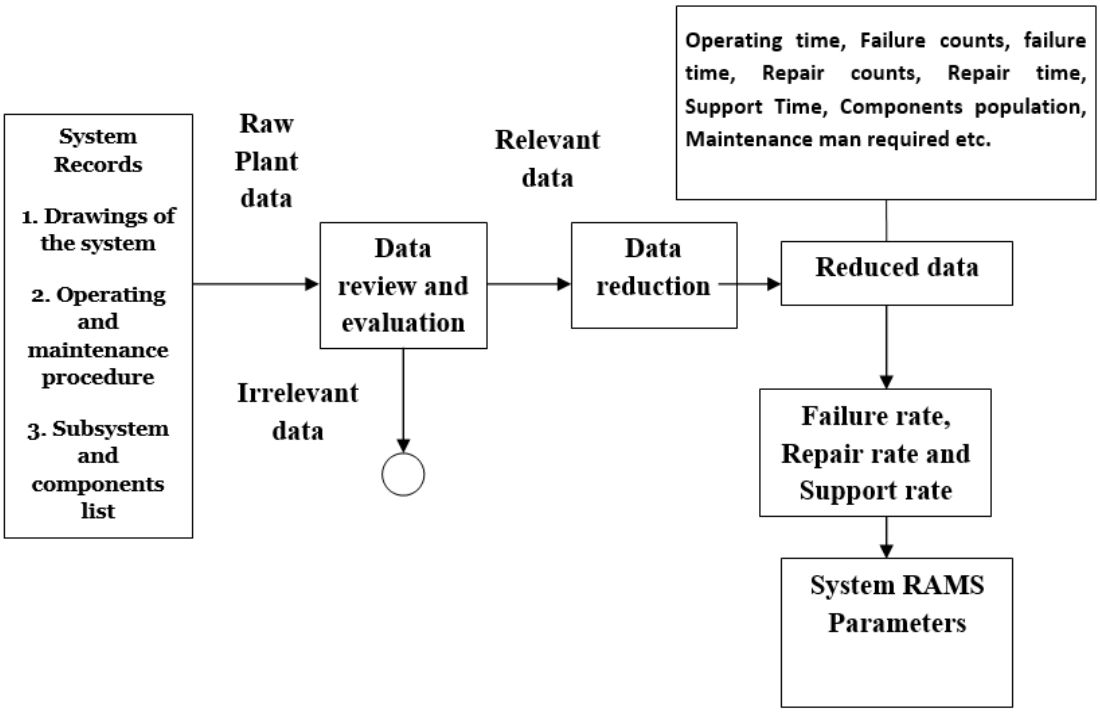
3. Database System

Development of RAMS database is a basically simple, then its successful implementation. The implementation of Developed database required a very sound knowledge of statistics and meticulous attention to details for analysis of RAMS characteristics. An approach, which we found suitable, is shown in Figure.1. This methodology could be used in variety of applications for RAMS Analysis program of an industrial system, RAMS tradeoff studies for industrial facility etc.

The database in this form will assist the RAMS engineers to conduct the RAMS analysis. Following are the some of the benefits of the developed database:

Benefits:

1. Provide training to RAMS engineer by highlighting main failure cause and events that have happened in the industrial system in past time.
2. Furnish RAMS data on industrial system, subsystem and parts of sub system which includes failure chance, failure modes and failure causes.
3. Support failure trend studies, decay or growth of failure rate or repair rate
4. Permit a quick search and query about the failure history of the system.



4. 4. Rams Data Analysis

The basic data for RAM analysis of an industrial system is collected by an expert team led by RAMS analysts and who are very familiar with the data available and retrieval system of data. The RAMS analysis approach is depend on the part and location of the industrial system and to the storage format like hard paper, hard disk, or a film etc. It also depends on individual types of data required but mainly the expert goes to the place where is information is kept physically. The teams examine and sort the record available and remove the unrelated material, and copy the related records for analysis and evaluation.

Data analysis is a process of converting the data collected into a simple assessed database which contains the parameters used to quantify RAMS characteristics. It usually comprises following tasks:

1. RAMS Database Design team
2. RAMS database design development
3. RAMS Data Sources and Collection
4. Coordination for collection and development of RAMS Models
5. Review and evaluation of Data
6. Reduction of Unnecessary data
7. Calculation of RAMS parameters for system, subsystem and its components.

4.1 RAMS Database Design team

In the beginning of any RAMS database development program is to create a team of experts. It should typically have one very much experienced RAMS data analyst, two technical assistant who is very familiar about industrial system, an engineer who is much aware about all the process of the system and some clerical staff for record keeping and maintaining the data usually two to four. The clerical staff should also have the capability to process the data under guidance of RAMS expert.

4.2 RAMS database design development

This step involves the selection of computer software to develop the database and to form a structure on the basis of the objective and requirement for the industrial system. It should not only be able to keep and manage the data but also to provide RAMS model, trades off. It should also be user friendly and should be very convenient in entry of new data.

4.3 RAMS Data Sources and Collection

The RAMS data source and collection team, which includes technician and engineering personal to find the following

1. Overview and assessment of available system data
2. Work facility familiarization of the industrial system for the RAMS team, and
3. Collection of basic data source documentation which is required for RAMS analysis.

4.4 Coordination for collection and development of RAMS Models

At this stage the RAMS database development team will communicate, coordinate and discuss with RAMS modeling team for their requirements of RAMS Models data, to ensure that system are modeled with adequate data. This process will help to have highest accuracy in development RAMS models which will provide the more accurate result for RAMS analysis.

4.5 Review and evaluation of Data

In this step, the unanalyzed data records will be evaluated by an expert who is familiar of RAMS analysis and the method & technology of the industrial system which is in consideration and the relevant data will be taken out for further analysis.

4.6 Reduction of Unnecessary data

The reduction of unnecessary data will be done by the extraction of the particular information from the available data for RAMS analysis, including number of system or quantity of system, number of system which are required, number of operating hours, total no of failure, failure mode etc.

4.7 Calculation of RAMS parameters for system, subsystem and its components.

At this step, the RAMS expert will use the extracted data to calculate and analyses the RAMS parameters. The RAMS parameters includes the failure probability in a length of operation time, , failure probability per operation , mean down time or system unavailability, mean repair time force by testing and by breakdown and preventive repairs, estimated confidence limit of mentioned entities.

5. Generation of System Performance Index (SPI)

A system performance index for the system, subsystem and its component has been developed on the basis of RAMS parameters, FMEA and LCC. The methodology has been developed in visual basic 6 with databases in MS Excel. The development of the software for the above methodology can be understood by following flow diagram:

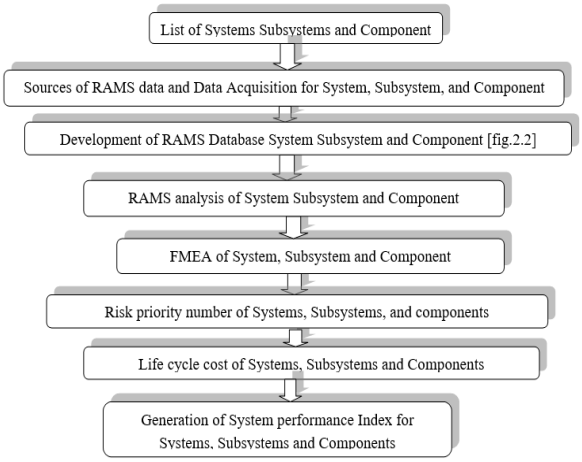


Fig. 3 Generation of system performance index (SPI)

The FMEA [6] of system/ subsystem provides the risk priority number in the range of zero to thousand and lifecycle cost [7] of any system subsystem and component has graded from zero to one and operational availability in the range from zero to one. The multiplication of all above three will provide us the system performance index in the range of zero to thousand.

The above developed methodology of RAMS analysis has been applied for RAMS analysis of electric locomotives of goods train in next chapter. The locomotive has been divided in eight subsystems and four hundred forty components. The raw maintenance data of fifty locomotives has been collected and database for these locomotives in ms excel has been prepared. The visual basic 6 has been used for coding the methodology and system performance index for each system, subsystem and components has been generated.

6. Conclusion

RAMS analysis is an effective way to evaluate performance of a system. In this paper RAMS based methodology had been developed to evaluate performance of a system in terms of system performance index (SPI). The developed methodology identifies the sources of data acquisition and provides database of system, subsystem and components failure probability, mode & cause. The developed database could also be used for quick search and query about the failure history of the system component/equipment, subsystem, and system. The RAMS analysis provides plots of RAMS parameters, their failure and repair pattern, their tradeoffs, failure rate, repair rate, and support rate etc. of system, subsystem and its

components. The System performance index based on RAMS, FMEA and LCC provides an idea whether the system, subsystem or component needs any improvement in design for improved performance or not.

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