Journal of Advances in Science and Technology
Vol. 19, Issue No. 1, March-2022, ISSN 2230-9659

A Study of Mathematical Model for Reliability Behavior in Operations Research

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Abstract - The reliability basics start with the coverage of the key concepts of probability. A broader definition of reliability is that "reliability is the science to predict, analyze, prevent and mitigate failures over time." It is a science, with its theoretical basis and principles. It also has sub-disciplines, all related - in some way - to the study and knowledge of faults. Reliability is closely related to mathematics, and especially to statistics, physics, chemistry, mechanics and electronics. In the end, given that the human element is almost always part of the systems, it often has to do with psychology and psychiatry. Indeed, we can try to derive from reliability also the availability performance of a system. In fact, availability depends on the time between two consecutive failures and on how long it takes to restore the system. Reliability study can be also used to understand how faults can be avoided. Reliability involves almost all aspects related to the possession of a property: cost management, customer satisfaction, the proper management of resources, passing through the ability to sell products or services, safety and quality of the product.

Keywords - Mathematical Model, Reliability Behavior, Operations Research, human element, Reliability involves

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INTRODUCTION

Many Operations Management efficiency assessments are based on research into component and process reliability. For instance, an estimate of availability is required in the calculation of the Overall Equipment Effectiveness (OEE) proposed by Nakajima. This has everything to do with trustworthiness. The availability of machines, which in turn is dependent on their dependability and maintainability, is a significant consideration in the study of service level. To be reliable, a part (or a whole system) must continue to function as intended while subjected to the conditions in which it was originally intended to function. Therefore, an exact specification of environmental circumstances and usage, as well as a clear criterion for determining whether or not something is functioning, are required for the definition of reliability. If we assume that a component is used for its intended function in its design environment and if we explicitly specify what we mean by "failure," then reliability can be defined as the time dependent probability of correct operation. According to this understanding, probability theory is where any discussion of dependability fundamentals must begin. To put it another way, "reliability is the science to predict, analyze, prevent, and mitigate failures over time." It has a theoretical foundation and guiding principles, making it a science. There are specialized areas within it that focus on specific aspects of error analysis. The fields of mathematics, notably statistics, physics, chemistry, mechanics, and electronics, all have important connections to reliability. Given that people are always involved in these systems, it usually boils down to issues of psychology and psychiatry. Reliability seeks solutions to a variety of issues, not just the longevity of a system. It is possible, in principle, to extrapolate a system's availability performance from its reliability. In fact, availability depends on the time between two consecutive failures and on how long it takes to recover the system. The study of reliability can also be utilized to learn ways to prevent malfunctions. Failures can be avoided by making changes to the design, materials, and maintenance. The capacity to sell products or services, as well as the product's safety and quality, fall under the umbrella of reliability, as do the control of costs, the satisfaction of customers, the efficient use of resources, and so on.

RELIABILITY BASICS

When any chemical-physical phenomena, said defect, occurs in one or more of the equipment's parts, determining a deviation of its normative performances, the period of normal operation of the equipment comes to an end. The result is unsatisfactory conduct on the part of the gadget. As time goes on, the equipment degrades until it eventually stops working altogether.

Transforming reality into a model that can be analyzed by applying laws and studying its behavior is essential for reliability research. There are two types of reliability models: static and dynamic. Failure in a static model is not assumed to cause more failures. Instead, dynamic reliability operates under the premise that certain failures—termed primary failures—cause the emergence of subsequent defects. Static models of reliability are all that will be discussed here. Each component's status is either "working" or "failed" in the static reliability paradigm. In turn, systems are made up of a fixed, integer number (n) of parts that operate independently of one another. The success or failure of a system is contingent on several factors, including the configuration used to build it and the functionality (or lack thereof) of its various parts.

Let's imagine an elemental X system as a generic example. State function Xi, representing the i-th component's operational status, is specified as in the static reliability modeling:

$$X_i = \begin{cases} 1 & \text{if the } i\text{-th component works} \\ 0 & \text{if the } i\text{-th component fails} \end{cases} \quad (1)$$

The state function is a model of the system's current operational state Φ(X)

$$\Phi(X) = \begin{cases} 1 & \text{if the system works} \\ 0 & \text{if the system fails} \end{cases} \quad (2)$$

The components are typically set up in a series configuration. When one part of a series system functions, the whole thing benefits. Consequently, a series system's status is defined by the state function:

$$\Phi(X) = \prod_{i=1}^{n} X_i = \min_{i \in \{1,2,\ldots,n\}} X_i \quad (3)$$

Where the symbol $\prod$ indicates the product of the arguments.

Reliability Block Diagrams (RBDs) are used to graphically illustrate the configuration of a system, with each component represented by a block and the connections between them expressing the configuration of the system. If you can't get from left to right in the diagram without going through the active parts, the system won't work. The RBD of a series system with four components is shown in Figure 1.

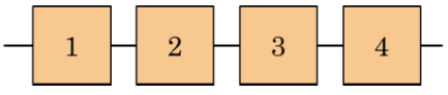

Figure 1- Reliability block diagram for a four components (1,2,3,4) series system

The series configuration is the most frequent, followed by the parallel configuration. For a parallel system to function, at least one of its parts must be operational. If one part of a parallel system fails to function, the whole system fails. Therefore, if -(X)is the function representing the non-functioning state of the system and X-i denotes the non-functioning of the i-th member, then:

$$\bar{\Phi}(X) = \prod_{i=1}^{n} \bar{X}_i \quad (4)$$

Thus, the state function describes the condition of a parallel system:

$$\Phi(X) = 1 - \prod_{i=1}^{n} (1 - X_i) = \coprod_{i=1}^{n} X_i = \max_{i \in \{1,2,\ldots,n\}} X_i \quad (5)$$

where the symbol $\coprod$ specifies the argument that is the complement of the complement of the arguments. A RBD for a parallel four-component system is shown in Figure 2.

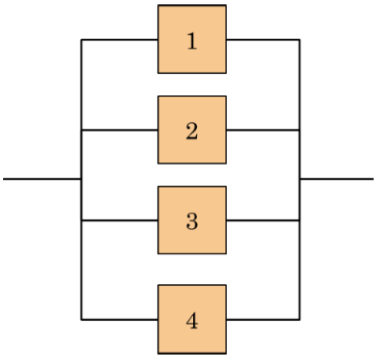

Figure 2- In a similar vein: The diagram depicts a reliability boundary diagram (RBD) for a parallel configuration of four parts (1,2,3,4).

Components can also be set up in a series-parallel arrangement. Components are combined in series and parallel configurations in these systems. Figure 3 illustrates one such arrangement.

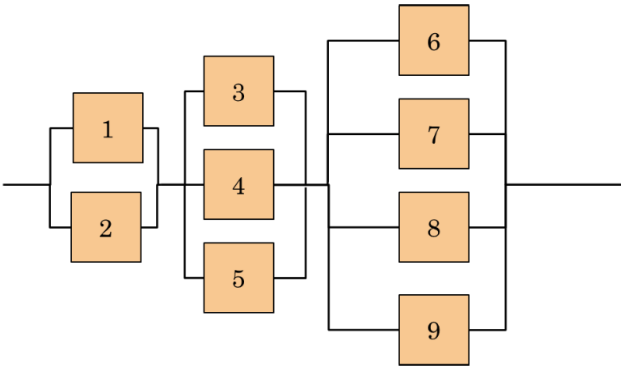

Figure 3. Parallel and series arrangement. The RBD of a system with 9 elementary units wired in series and parallel is depicted.

Decomposing the system into its constituent parts yields the state function of a series-parallel system. This method involves dividing the system into parallel or series arrangements, or even smaller subsystems. The configuration of the subsystems

determines how their state functions should be merged.

The parallel k-out-of-n configuration is one of the most common and well-known component layouts. If k of the n parts of a system are functional, then the system is considered to be functional. Keep in mind that a parallel system is a system 1 out of n and a series system is a system n out of n. The following algebraic system describes the state function of system k out of n:

$$\Phi(X)=\begin{cases}1 & if \sum_{i=1}^{n} X_i \geq k \\ 0 & otherwise\end{cases} \quad (6)$$

Adding the label "k out of n" to the RBD schema of a parallel system with n components makes the RBD for system k look exactly the same as it does for system n. When constructing the state function of a more complex system configuration, like the bridge configuration

The Minimal Path Set (MPS) is a subset of the system's components whose joint operation implies the system's operation. Due to this attribute being lost when even one member is removed from the subset, the set is small.

The term "Minimal Cut Set" (MCS) refers to a subset of the system's components where the failure of all of those components does not indicate the system's inability to function. Although this quality is lost if any element of the subset is removed, the set is still considered small. Equivalent configurations of more sophisticated systems, not reducible to the fundamental series-parallel model, can be built with MCS and MPS. The first comparable configuration is grounded in the idea that the functioning of all parts, in at least an MPS, necessitates the functioning of the system as a whole.

CONCLUSION

All this has led to the situation that reliability has become one of the most important technical problems and reliability theory has become an independent scientific discipline. In the fast developing countries, like India, recent technologies in the electrical and electronic equipment's are being used on mass scale in many industries. Industries are trying to introduce more and more automation in their industrial processes in order to meet the ever-increasing demands of society. The information drawn from studies on reliability, during last 25-30 years, has been proved of enough importance and thus in attracting much attention of farsighted industrialists. Moreover through these studies, we have been able in reducing the failure risks in industries, defence and space research programmes. The failure of the complex system can often cause effects, which range from inconvenience and irritation to a severe impact on society and on its environment. Users expect that the products and system they purchase should be reliable and safe. In consequences, a considerable awareness has been developed in the application of such techniques in the design and operation of simple and complex systems.

REFERENCES

1. Bansal, AK and Indianan, A.: IndPediatr (1993) 30, 1251-58.
2. Bard, JF and HW Purnomo. European Journal of Operation Research, 2004.
3. Bard, JF, C. Binici, and AH De Silva: Computers & Operations Research, 30: 745-771, 2003.
4. Bard, JFand HW Purnomo: Socio-Economic Planning Science, 2004.
5. Beasley, D, D Bull, and R Martin: University Computing, 15 (2): 58-69, 1993.
6. Bector, C.R.: Math. Anal. Appl. (2000). 251, 3
7. Beddoe, GR and S Petrovic: Annals of Operations Research, 2004.
8. Beddoe, GR and S Petrovic: European Journal of Operation Research, 2004.
9. Beddoe, GR and S. Petrovic: Artificial Intelligence, 2004.
10. Beloff, JS, and Korper, M: The health team model and medical care utilization JAMA, 219: 3, 1972.
11. Bergmann, R and W Wilke: Journal of Artificial Intelligence Research, 3: 53-118, 1995.
12. Bergmann, R. H Munoz: AI Communications, 9 (3) : 128-137, 1996.
13. Bhattacharya, A.: Sankhya(1946) 7, 401-6.
14. Birnbaum, L and G Collings: In Proceedings of Second Workshop on Case-Based Reasoning, 1989.

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