Reliability Analysis and Life Cycle Cost Optimization of Centering & Plunge Facing Machine (500)

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Abstract— It is important to analyze the reliability of a centering and plunge facing machine because its low reliability can hamper the production rate. Also life cycle cost optimization of the machine can help producer to meet customer demand and increase profitability of firm. This paper provides a review on Reliability Analysis and Life Cycle Cost Optimization of Centering & Plunge Facing Machine (500) in order to improve reliability and profitability of producer.

Key words: Cost Optimization, Plunge Facing Machine (500), Centering Facing Machine

I. INTRODUCTION

From last few decades economical approaches of the industries is continuously changing. Now days focus of industries are increasing on microscopic level than macroscopic level. To cope with other competitors, many machine tool manufacturers have begun to give importance to the reliability of machine tools. Because expensiveness and complexity of these machine tools analysis of their field failure data becomes important.

Informed customers not only weigh the ability of the product to meet their requirements, and the purchase price of the product, but also the costs that will be incurred to maintain the function of the product over its life time. Hence, reducing the maintenance cost of a product will increase its value and attractiveness to the customer. The reliability based design focuses on three terms such as reliability, availability and maintainability. Reliability is defined to be the probability that the component or system will perform its intended functions for a specified period of time when used under stated operating conditions. In simple words, reliability is nothing but the non-failure of the system over a given period of time. Maintainability is defined as the probability that an item will be retained in or restored to a specified condition within a given period of time. Availability is defined as the probability that a component or system is performing its required function at a given point in a time when used under stated operating conditions. Availability may also be interpreted as percentage of time a component or system is operating over a specified time interval or the percentage of components operating at a given time. Availability can be mathematically defined in several different ways, depending on how system uptime and downtime are measured. It differs from reliability in that availability is the probability that the component is currently in a non-failure state even though it may have previously failed and have been stored to its normal operating conditions. Therefore, system availability can never be less than system reliability.

II. CENTERING AND PLUNGE FACING MACHINE (500)

FIE Group Company-SPM TOOLS, Ichalkaranji are leading manufacturers of Centering & Plunge Facing Machine. These machines are used in small scale as well as large scale industries for catering, plunge facing, chamfering and external turning of the two ends simultaneously of the bar stock, such as camshaft, crankshaft, motor-shaft, universal joint etc. They are used for mass production. For increasing saleability, durability and compete their competitors, research, redesign and development work is going on. The main objective of this research is to improve reliability, and optimize the total life cycle cost in order to increase availability. Shown in Fig. 1 is most sellable and used for mass production.

Fig. 1: Centering and Plunge Facing Machine (500)

The failure of this model is not economical for customers. Due to this reason, this model is selected for reliability analysis and life cycle cost optimization. Table 1 depicts the specifications of Centering and Plunge Facing Machine (500)

Parameters	Specification
Capacity	
Possible work piece length	500 mm
Min work piece dia. admitted in vice	12 mm
Max work piece dia. admitted in vice	125 mm
Spindle speed	350 RPM
Maximum stroke of each quill	50 mm
Max. Plunge facing dia.	63 mm
Center drill size	BS 3
Motor power	
Spindle motor each	2.2/960 kW/RPM
Hydraulic power pack	3.37/1440 kW/RPM
Coolent motor	0.1/2800 kW/RPM
Total power	7.87 kW

Table 1: Specifications of Centering and Plunge Facing Machine (500)

III. RELEVANCE

Now a day reliability, maintainability and product life cycle cost optimization has become the focussed area of interest. Reliability aspect is essential in design of any product or system due to the increased complexity and sophistication of

systems, awareness of customers and high cost of maintenance etc. Reliability is a probability. This means that failure is regarded as a random phenomenon. Reliability is estimated by analyzing the failure data. Different reliability models are used to determine various measures of reliability such as a mean time between failure (MTBF) and mean time to failure (MTTF). MTBF is affected by the known or predicted stresses, environmental factors, operating conditions, material properties and part geometries. Reliability model gives critical modes and parameters of failures. Many failures however are much more significant in both their economic and safety aspect.

A maintenance cost is a significant part of the overall operating costs. The important aspect is considered in reliability based design, is that reliability should not increase too much cost of the product or system. Hence, to reduce the overall contribution of the running or operating cost reliability is important. Taking into consideration the importance of reliability, it is decided to carry out reliability analysis of a centering & plunge facing machine (500) manufactured by SPM TOOLS, (Yadrav) Ichalkaranji.

IV. LITERATURE REVIEW

Many studies have been reported in the published literature. In this section, some of the reliability studies conducted over the years have been re-visited, highlighting the applications and methodologies used.

Yiquiang et al [3] In the design and development of CNC lathes, an effective reliability allocation method is needed to allocate system level reliability requirements into subsystem and components levels. During the allocation process, many factors have to be considered. Some of these factors can be measured quantitatively while others have to be assessed qualitatively. They had considered seven criteria for conducting reliability allocation and finded its actual value. Frequency of failure, criticality of failure, maintainability, complexity, manufacturing technology, working conditions, cost and machine is divided into 15 subsystem. He compared allocated MTBF and observed MTBF. Finally he concluded, reliability allocation of CNC lathe should consider various factors such as the performance, design, manufacturing, use, maintenance, cost and reliability of the system.

Yiquiang et al [4] fields failure data for CNC lathe was collected over a period of two years on approximately 80 CNC lathes. A coding system to code failure was devised and a failure analysis date bank of CNC lathe was established. The failure position and subsystem, failure mode and cause were analyzed to indicate the weak system of CNC lathe.

Dai et al [5] Over a period of two years, they have investigated the failure data of 14 VMC and have found the distribution of failure mode and that of failure position, causes of failure and the way to enhance the reliability of the VMC.

Keller et al. [6] described a reliability and maintainability study of CNC system. For this analysis field failure data was collected in a period of three year on 35 CNC machines during their warranty period were analysed. In order to apply quantitative reliability methods, a coding system was devised and failure data which were then collected into a data bank. The Lognormal and Weibull distribution was found to be applicable to describe time between failures and the repair times. The Duane reliability growth model arising from the introduction of modifications to improve machine tool performance gave a good fit to the observed reliability growth for a CNC system.

Barabady et al. [7] presented reliability and availability analysis of the crushing plant no-3 at Jajarm Bauxite Mine in Iran. In this case study, the crushing plant is divided into subsystems. The parameters of some probability distributions, such as Weibull, Exponential, and Lognormal distributions have been estimated by using Reliasofts weibull ++6 software and from results, it was concluded that the conveyer subsystem and secondary screen subsystem are critical from a reliability point of view, and the secondary crusher subsystem and conveyer subsystem are critical from an availability point of view. It was further shown that the reliability analysis is very useful for deciding preventive maintenance intervals for different reliability levels.

Kumar et al. [8] concluded that reliability of equipment is extremely important to maintain quality. This is achieved by using proper maintenance and design changes for unreliable subsystems and components of a complex system. It is significant to develop a strategy for maintenance, replacement and design changes related to those subsystems and components. An analysis of down time along with causes is essential to identify the unreliable components and subsystems.

Waghmode et al. [9] used Fault Tree Analysis method to find out major faults or critical failures associated with product and the causes for the faults and potential countermeasures for lathe machine. Qualitative and quantitative analysis helps to identify critical design parameters. It is also shown that how reliability analysis fruitful for Life cycle cost management.

Waghmode et al. [10] analysed and concluded that the initial price is not the only criteria of the procurement. Most of the cost is associated with the hazard rate or failure rate of the product during the life cycle of the product. From the study on reliability analysis of a typical heavy usage multi-stage centrifugal pump, it is found that initial cost is a fraction of the total cost.

Barringer et al [11] emphasized the need of practical reliability details to define life cycle costs of the product. Life cycle cost comparisons help to decide the lowest long-term cost of ownership driven by a single estimator called net present value. The net present values require decisions about when and how much maintenance or replacement costs will be incurred which is driven by the time and modes for component failures found by using reliability technology.

Jun et al [12] this paper conducts the reliability modelling of aircraft equipment and predicts its MTBF. The results shown that reliability analysis and the application of FMECA method prolong the lifespan of this equipment and improves the operational reliability greatly.

The above review shows that reliability analysis technique has been applied to evaluate different types of systems. In this work it is proposed to apply this technique to analyse the reliability of Centering & Plunge Facing Machine (500). The effect of reliability on the life cycle cost of the same machine will also be studied.

V. METHODOLOGY

The methodology which will be followed for the reliability analysis and life cycle cost optimization of the Centering & Plunge Facing Machine (500) comprises the following:

(1) Understanding the system, identification, coding of the subsystems and the faults therein;
(2) The collection, sorting, classification of the TBF and TTR data for each subsystem, their fault;
(3) Data analysis by Relifoft Weibull ++9 for verification of the assumption of independent and identically distributed TBF, TTR data;
(4) Fitting the TBF and TTR data for the subsystems and faults with a theoretical probability distribution;
(5) The estimation of the reliability and maintainability parameters of each subsystem with a best-fit distribution;
(6) The identification of critical subsystems, faults and the formulation of a better maintenance policy to improve reliability.
(7) The improved life cycle cost of Centering & Plunge Facing Machine (500) will be approximately estimated based on reliability improvement methods.

VI. CONCLUSIONS

From this review it is observed that Reliability Analysis and Life Cycle Cost Optimization of Centering & Plunge Facing Machine (500) provide opportunity to increase reliability of machine. Also due to life cycle optimization will increase profitability of the firm. This review shows that;

- Many researchers agreed that by reliability analysis several deficiencies, reasons of failure can be find out and by using this data several improvements in machine can be done to improve its reliability and profitability.
- Many new effective reliability analysis tools are available for researchers.
- Life cycle cost analysis can provide different costs associated with the machine tools throughout its life, this data will be helpful for the economic decision making.

REFERENCES

[1] Charles E. Ebling, "Introduction to Reliability and Maintainability Engineering", TataMc-Graw Hill Publishing House, Edition 2000.
[2] www.spmtools.co.in. SPM TOOLS, (Yadrav) Ichalkaranji.
[3] Yiquiang Wang, Richard C.M. TYam, Ming J. Zuo, Peter Tse. "A comprehensive reliability allocation method for design of CNC lathes". Reliability Engineering and System Safety, Page no.247-252, February 7, 2001.
[4] Yiqiang Wang, Yazhou Jia, Junyi Yu, Yuhua Zuhua Zheng, Shangfeng Yi " Failure probabilistic model of CNC lathes". Reliability Engineering and System Safety, Volume 65, Page no.307-314, 1999.
[5] Yi Dai, Yazhou jia, "Reliability of a VMC and its improvement", Reliability Engineering and System Safety, Volume 72, Page no.99-102, 2001.
[6] A.Z.Keller, A.R.R Kamathi, "Reliability Analysis of CNC Machine Tools." Journal of Reliability engineering, Volume 3, Page no. 449-473, 1982.
[7] Javad Barabady, Uday Kumar, "Reliability Analysis of Mining Equipment: A Case Study of a Crushing Plant at Jajarm Bauxite Mine in Iran". Reliability Engineering and System Safety, Page no. 647-653, 2008.
[8] Saurabh Kumar, Gopi Chattopadhyay, Uday Kumar, "Reliability Improvement through Alternative Designs-A Case Study." Reliability Engineering and System Safety, Page no.983-991, February 6, 2007.
[9] L. Y. Waghmode, R. B. Patil, "An Overview of Fault Tree Analysis (FTA) Method for Reliability Analysis." Journal of Engineering Research and Studies, Volume 4, Page no. 6-8, January 2013.
[10] L. Y. Waghmode, A. Sahastrabhudhe, P. Kulkarni, "A Life Cycle Cost of Pump Using An Activity Based Costing Methodology." Journal of Mechanical Design, Volume 132, Page no.121006-1 to 121006-9, December 2010.
[11] H. Paul Barringer, "Why you need practical reliability details to define life cycle costs for your products and competitors' products?" www.barringerl.com.
[12] Li Jun, Xu Huibin, "Reliability Analysis of Aircraft Equipment Based on FMECA method." 2012 International Conference on Solid State Devices and Material Science, page no 1866-1822, march 3, 2012.
[13] H. Paul Barringer, "An Overview of Reliability Engineering Principles" www.barringerl.com.

