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A CASE STUDY ON REPLACEMENT THEORY TO ESTIMATE THE ECONOMIC LIFETIME OF AN OFFSET PRINTING MACHINE

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Replacement Theory, which is a branch of Operations Research, deals with determining the optimal time to replace equipment, assets, or components to minimize their operational and maintenance costs, and maximize operational efficiency. For industries that depend on machine intensive processes, identifying the optimal time to replace the machine is essential to maintain cost-effective operations. This study proposes a mathematical model to find the economic life of an offset printing machine which enables efficient cost management. In this study, Heidelberg SM74-4 offset printing machine is considered as a case study to demonstrate the model. The factors considered in the development of the model are operational costs, maintenance costs, depreciation, electricity consumption, and bank loan payments. In this study, to make it more realistic, the present value of money is also incorporated into the model. The objective function of the model is the Average Total Cost (ATC) which is calculated using the sum of all related expenditures, including maintenance and operating costs of the machine. To determine the time to replace the machine, the ATC is calculated for each year, when the machine is in operation. This yearly calculation terminates when the ATC, which is a unimodal function, reaches its critical point. The critical point is proven to be the most economical point to replace the machine. This study has a great impact on the printing and manufacturing industries in addition to its theoretical achievements. It determines the optimum replacement time for the Heidelberg SM74-4 by considering factors such as maintenance, energy, and loan payments. The findings show that the economic life of the machine ends after 17 years, even though it was in operation for 20 years. This extended time period shows the machine's durability but also highlights increased costs and declining efficiency over time. While the model offers a practical framework for making decisions on replacements, it does not currently account for factors like inflation and market fluctuations. Future improvements could enhance its relevance and adaptability. In conclusion, this data-driven approach supports timely and cost-effective decision-making, improving operational efficiency and financial outcomes in machinery-dependent industries.

Keywords: Average total cost, Machine replacement, Offset printing, Operational efficiency, Replacement theory