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Healthcare Asset Replacement Problem Under Technological Change and Deterioration

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In this study, we study the multiple style and type parallel asset replacement problem (MUST- PRES), which determines an optimal policy for keeping or replacing a group of assets that operate in parallel under a limited budget and a fixed purchasing cost. Operating assets generally suffer from deterioration, which results in high operation and maintenance costs and decreased salvage value, while technological improvements make it possible for new assets to operate more efficiently at a lower cost. In order to address these issues, we formulate a multi-objective optimization model, which minimizes fixed and variable costs of purchasing new assets, while considering a combined effect of technological change and deterioration as a gain and loss in capacity, respectively. The optimization model also allows some demand to be unmet due to strict budget limitations while imposing a penalty when demand is not met in each period. We apply our model to a case study of healthcare assets involving two different types of assets: a full- body magnetic resonance imaging (MRI) machine and a smaller-extremity MRI (eMRI) machine. Each MRI and eMRI machine has two types: high-field and low-field. We perform computational experiments and sensitivity analysis using key model parameters, and present study results for four cases of technological change and deterioration to illustrate optimal replacement strategies. Numerical results show that the proposed optimization model provides valuable insights and strategies for companies, decision-makers, and government entities on optimal asset replacement as well as healthcare asset management.