ABSTRACT

As installed equipment ages, its operating and maintenance (O&M) costs increase due to deterioration. However, its salvage value and annual capital costs decrease due to aging and obsolescence. These facts indicate that the installed equipment should be replaced. Depending upon its economic service life, it is economical to replace the installed equipment (defender) with new equipment (challenger) when the total annual costs (O&M plus capital costs) reach their minimum value.

Furthermore, due to technological changes, the challenger typically performs better than the defender. The O&M costs of the challenger are initially lower and increase at a slower rate (lower deterioration rate) than those of the defender, while the salvage value of the challenger decreases at a slower rate (lower obsolescence rate) than that of the defender. However, the initial purchasing price of the challenger can be either lower or higher than that of the defender.

In this study, one of the commonly used replacement decision methods, the challenger-defender (CD) method, is modified. The proposed method outperforms the original CD method, and in some cases, it outperforms the original economic life (EL) method as well. When the annual multiplier for the purchase price ($a$) is higher than that
for the new-asset O&M costs \((q)\), the solution of this modified CD method is more advantageous than the EL method if the new-asset O&M costs purchased at time 0 \((A)\) are higher. Furthermore, for the same \(A\), this modified CD method is more advantageous than the EL method when the annual effective discount rate \((d)\) is lower.

This study also shows that the service life of the new equipment can be shorter than, longer than, or identical to that of its predecessor depending upon the purchase price and the initial O&M costs of the new equipment considering technological changes.

We also show that the service life of the equipment can be shorter than, longer than, or identical to that of its predecessor, depending upon the purchasing price and the initial O&M costs of the new equipment, including the implications of technological change.

In this study, we also examine the effect of an overhaul policy on the replacement problem; with technological changes, capital asset replacement has a significant impact on company cash flow because it is expensive to invest in new assets. An overhaul policy can extend the optimal service life of an asset and results in a lower total life cycle cost. Technological changes also affect the life cycle cost and the optimal service life of an asset. In this study, we examine both the replacement/renewal and
overhaul/refurbish policies in a model that factors in technological change. We use a System Dynamics model to simulate hypothetical data for 4 cases, and the output is in line with some previous studies using analytical models.