

## Planning Quality and Maintenance Activities in a Closed-Loop Serial Multi-Stage Manufacturing System under Constant Degradation

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**Abstract :** This research presents the development of a self-sustainable manufacturing system from a circular economy perspective, structured by a multi-stage serial production system consisting of a series of machines under deterioration in charge of producing a single product and a reverse remanufacturing system constituted by the same productive systems of the first scheme and different tooling, fed by-products collected at the end of their life cycle, and non-conforming elements of the first productive scheme. Since the advanced production manufacturing system is unable to satisfy the customer's quality expectations completely, we propose the development of a mixed integer linear mathematical model focused on the optimal search and assignment of quality stations and preventive maintenance operation to the machines over a time horizon, intending to segregate the correct number of non-conforming parts for reuse in the remanufacturing system and thereby minimizing production, quality, maintenance, and customer non-conformance penalties. Numerical experiments are performed to analyze the solutions found by the model under different scenarios. The results showed that the correct implementation of a closed manufacturing system and allocation of quality inspection and preventive maintenance operations generate better levels of customer satisfaction and an efficient manufacturing system.

**Keywords :** closed loop, mixed integer linear programming, preventive maintenance, quality inspection

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