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The Effect of Improvement Programs in the Mean Time to Repair and in the Mean Time between Failures on Overall Lead Time: A Simulation Using the System Dynamics-Factory Physics Model

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Abstract : The importance of the correct allocation of improvement programs is of growing interest in recent years. Due to their limited resources, companies must ensure that their financial resources are directed to the correct workstations in order to be the most effective and survive facing the strong competition. However, to our best knowledge, the literature about allocation of improvement programs does not analyze in depth this problem when the flow shop process has two capacity constrained resources. This is a research gap which is deeply studied in this work. The purpose of this work is to identify the best strategy to allocate improvement programs in a flow shop with two capacity constrained resources. Data were collected from a flow shop process with seven workstations in an industrial control and automation company, which process 13.690 units on average per month. The data were used to conduct a simulation with the System Dynamics-Factory Physics model. The main variables considered, due to their importance on lead time reduction, were the mean time between failures and the mean time to repair. The lead time reduction was the output measure of the simulations. Ten different strategies were created: (i) focused time to repair improvement, (ii) focused time between failures improvement, (iii) distributed time to repair improvement, (iv) distributed time between failures improvement, (v) focused time to repair and time between failures improvement, (vi) distributed time to repair and between failures improvement, (vii) hybrid time to repair improvement, (viii) hybrid time between failures improvements, (ix) time to repair improvement strategy towards the two capacity constrained resources, (x) time between failures improvement strategy towards the two capacity constrained resources. The ten strategies tested are variations of the three main strategies for improvement programs named focused, distributed and hybrid. Several comparisons among the effect of the ten strategies in lead time reduction were performed. The results indicated that for the flow shop analyzed, the focused strategies delivered the best results. When it is not possible to perform a large investment on the capacity constrained resources, companies should use hybrid approaches. An important contribution to the academy is the hybrid approach, which proposes a new way to direct the efforts of improvements. In addition, the study in a flow shop with two strong capacity constrained resources (more than 95% of utilization) is an important contribution to the literature. Another important contribution is the problem of allocation with two CCRs and the possibility of having floating capacity constrained resources. The results provided the best improvement strategies considering the different strategies of allocation of improvement programs and different positions of the capacity constrained resources. Finally, it is possible to state that both strategies, hybrid time to repair improvement and hybrid time between failures improvement, delivered best results compared to the respective distributed strategies. The main limitations of this study are mainly regarding the flow shop analyzed. Future work can further investigate different flow shop configurations like a varying number of workstations, different number of products or even different positions of the two capacity constrained resources.

Keywords : allocation of improvement programs, capacity constrained resource, hybrid strategy, lead time, mean time to repair, mean time between failures
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