Work Study and Simulation Optimization of Supply-Demand Balancing in the Moth Orchid Plant Factory

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Abstract

This study develops a two-stage framework. An empirical study of a moth orchid plant factory is conducted. The first part includes developing the standard operating procedures (SOP) by eliminating seven muda (e.g., transportation waste, etc.) based on the lean production management for the plant factory. The second part is that we build up a simulation model of the production process via the SOP. By collecting global trade data, we estimate the supply distribution of the case factory as our output distribution and obtain the input portfolio with minimal cost by simulation optimization techniques to address the supply-demand mismatching problem.

Keywords: Work Study, Simulation Optimization, Supply-Demand Balancing, Lean Production Management, Standard Operating Procedures

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1. Introduction

Unlike other manufacturing products, moth orchid is generally labor-intensive and takes a really long lead-time (i.e., around three-to-four years) from birth to sale. A factory can be simply divided into sub-areas such as tissue culture, warm room, cold room, package and sales. The production line generally presents unstructured process flow and needs experienced workers to guide the customized jobs in the shop-floor level due to organic products. Three issues are urgent to be dissolved. First, due to the labor-intensive and relatively high employee turnover rate, the standard operation process (SOP) is urgent to build up. This study would like to assess the standard processing time of each process through the time-motion study and investigate the transportation routes in the existing layout for improving the productivity.

Second, the energy expenditure presents the large amount in the cost structure; in particular, the electricity consumption of air condition for temperature control. The warm room and cold room occupy the large areas of the factory layout, and these two rooms dynamically adjust the energy consumption (e.g., electricity and water) according to the weather changes or seasonal effects. To effectively save the electricity cost, the electrical contract capacity is crucial where the firm request a pre-determined usage of electricity consumption to the power plant, and then the capacity surplus and shortage will cause an extra expenditure. Thus, this study proposes linear programming techniques embedded with the goal programming constraint to balance the two-sided risk and provide a robust capacity level of contract design for cost reduction.

During this four-year production lead-time, there are several inevitable or uncertain factors (e.g., weather, insect pest, plant disease) which would have a negative impact on the quality of moth orchids; besides, the market fluctuation during the long lead-time results in difficulties of decision-making and unstable income of the company. Therefore, this study tries to build up a supply-demand balancing model and address this issue.

An empirical study is conducted in a new moth orchid plant factory in Taiwan. Because it’s a start-up company, before we build up a supply-demand balancing model, we should eliminate seven muda (e.g., transportation waste, inventory waste, etc.) and develop the standard operating procedures (SOP) for the case factory. Hence, this study
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