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OPTIMIZING PRODUCTION ALLOCATION WITH SIMULATION IN THE FASHION INDUSTRY: A MULTI-LEVEL HIERACHICAL OPTIMIZATION FRAMEWORK PROPOSAL

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ABSTRACT

Production Planning and Control (PP&C) has been deeply analyzed in the literature, both in general terms and focusing on specific industries, such as the fashion one. This work add a contribution in this field presenting a multi-level hierarchical optimization framework for the fashion industry and an environment composed by focal companies and both exclusive and not-exclusive suppliers. The relevant aspect of this work is related to the peculiarities of this industry, where daily produced quantities differs from the long-term planned ones and where multi-brands suppliers capacity is unknown to focal companies. The proposed framework combine simulation and optimization models based on parameters, decision variables, constraints and Objective Functions (OFs) collected through a literature review. The framework has been developed in a parametrical way, in order to fit the peculiarities of the Fashion Supply Chain (FSC).

1 INTRODUCTION

PP&C optimization of a multi-level Supply Chain (SC), composed by small companies coordinated by a big company (usually the brand owner in the fashion industry), has been widely discussed in the literature from different points of view. Several approaches in the definition of scheduling formulation can be found. Published reviewing papers study different problems, moving from single to parallel machines, job or flow shop, and considering different level of data aggregation, even if only few of them deals with the fashion industry (e.g. Ait-Alla et al. 2014; Du et al. 2017; Guo et al. 2015; Wong et al. 2014). Considering the OFs, costs minimization represents the main purpose of the reviewed works, even if several authors consider multi-objective production planning problem in the labor-intensive manufacturing industry. The OFs included in the reviewed papers are related to production costs, tardiness, throughput and idle time, hiring and layoff costs associated with the change of workforce level, total setup, inventory and backorder costs. Multiple OFs are often defined as a total cost that has to be minimized. All of these models consider the optimization of a single level of the SC, using as input the production plan received from the upper level and defining the scheduling and the delivery plan for the lower level of the SC, assuming as known the capacity of brand owners' suppliers and sub-suppliers.

2 PROBLEM STATEMENT

One of the characteristics of the fashion industry, due to the presence of seasons (i.e. Fall/Winter), is that brand owners' demand is usually concentrated in short periods with a high pressure on the same supply base. Moreover, every focal company, according to its Critical Success Factors (CSFs), has different objectives and requirements in the production plan development. According to this, every supplier receive a production plan from one or more brand owners composed by orders with different and often opposite targets (i.e. due date respect, low labor cost, high quality etc..) that have to be fulfilled in a short time. Fashion labor suppliers, usually called façonists, can be exclusive and not-exclusive, meaning that they work for one or more focal companies. Not-exclusive façonists, as a matter of fact, despite the pressure of

the brand owners, define their production plan according to their CSFs, that are different from the brand owners' ones. Moreover, aiming to collect the largest number of orders to maximize their production lines saturation, they do not share their real-time capacity with brands, but declare only their total available capacity. Consequently, brand owners finite capacity production planning software usually overestimate suppliers' capacity and, as result, the delivery date requested by brand owners does not match with real data.

3 RESEARCH OBJECTIVES

Starting from the boundaries described above, the research aims to define a framework where a simulation-optimization model has the objective to overcome these limits defining an algorithm able, as first result, to define an optimization model suitable by the different SC actors. Used iteratively, firsts by brand owners then by suppliers, the model will be able to help the brand owners in the determination of the façonists capacity and, as a second step, to provide a support to identify the sub-optimal brand owners' and suppliers' production plans, starting from the declared suppliers capacity. According to the first objective, the optimization model has been developed in order to fit the different companies' peculiarities including an OF defined as a combination of weighted parameters chosen by the single company and reflecting its CSFs. In particular, the solver has been developed with the following linear function OF: $\text{Min}\{\sum_{i \in I} (cw_i * C_i + dw_i * D_i + aw_i * A_i + ptw_i * PT_i)\}$, where cw_i, dw_i, aw_i, ptw_i, are the weights of the various objectives, and C_i, D_i, A_i, and PT_i are respectively the costs, the delays, the advances and the processing time related to the production of the item i. As second result, a "what-if" simulation analysis is included in the model, in order to show how the optimized results and the related KPIs can differ considering the uncertainty due to both internal (e.g. machine failures, reworks, etc..) and external stochastics events (e.g. changing in brands' production plan) at the supplier level. Moreover, simulation can be used to compare the impacts on KPIs resulted from different implementation of the optimization model in terms of changed inputs, such as OFs' weights or suppliers' production capacity. The model is composed by a discrete-event simulator, AnyLogic®, and an open solver optimization tool, OpenSolver, integrated on Microsoft Excel®.

4 PRELIMINARY RESULTS

At the moment, the simulation-optimization model has been applied into two different contexts. The first one is a brands' both first- and second-tier supplier, producing metal accessories. The second one is composed by two brand owners and a subset of their supply base. The model has been applied using different OF parameters, according to the CSFs of the different companies, and considering both production time than an equivalent unit produced per day in order to evaluate suppliers capacity.

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