Proceedings of the 2021 Winter Simulation Conference
S. Kim, B. Feng, K. Smith, S. Masoud, Z. Zheng, C. Szabo and M. Loper, eds.

SUPPLY CHAIN REDUCTION IN REGULATED MARKETS

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ABSTRACT

This paper investigates the impact of a complexity-reduction project conducted in the life science industry for regulated products. The paper presents the complex infrastructure of antibody manufacturing and distribution and benefits which can be gained by applying discrete-event simulation to reduce complexity in an regulated environment. The digital twin model allows us to evaluate multiple scenarios to support decision making when redesigning a supply chain for regulated products. The base case and the complexity-reduced case allow us to evaluate the potential benefits of complexity reduction on the total supply chain costs and other key performance indicators. Based on our analysis, we identify significant improvements.

1 INTRODUCTION

Globally-structured life-science organizations face constantly-changing business environments, complex barriers, and financial risks while managing supply chains spread across the world. In this study, we investigate how to reduce supply network complexity to improve financial performance within the life-science sector. Regulations, formal standards, and far-reaching directives for medical applications add tremendous complexity to this sector. However, the research on the management of supply network complexity for regulated products, and life-science products in particular, is limited.

The trend of adopting digital technologies in the life-science sector is increasing and almost seen as indispensable (Steinwandter *et al.*, 2019). Within this broader trend, we put forward a digital-twin model to reduce the complexity of a supply network devoted to the production of antibodies. The manufacturing and distribution of antibodies recently gained significant attention because of they are widely employed in SARS-CoV-2 test kits. Enhancing the antibody supply chain is crucial because of its wide-ranging medical applications. However, this is not an easy task because of the inner complexity of the manufacturing and purification processes of antibodies (Li *et al.*, 2010). Our model offers a relevant contribution to solve this problem.

2 CASE STUDY SUPPLY CHAIN FOR ANTIDBODIES

In this paper, we aim to redesign the supply chain that manufactures and distributes antibodies with the aim of enhancing supply chain economic activities and address current and future pain points like supply chain disruptions.

The simulation model allows us to represent the dynamic behavior of the antibody supply chain and assess the total supply chain cost for different supply chain configurations. The total supply chain cost is given by the sum of the following costs: processing costs, logistics and transportation costs, and inventory holding costs. The manufacturing and purification process for antibodies is complex. To measure the efficiency and effectiveness of an alternative supply chain design, additional performance indicators have been identified and measured. These include the processing times, the logistics and transportation times, and the end-to-end lead times.

The aim of this study is to redesign an existing supply chain and to evaluate its impact on costs and times. Figure 1 depicts the base model (AS-IS) and Figure 2 depicts the complexity reduced model (TO-BE).

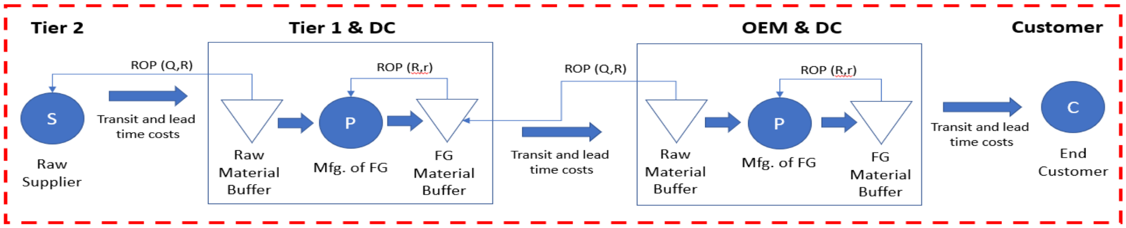

Figure 1: Base Case Business Process Model Antibody Manufacturing.

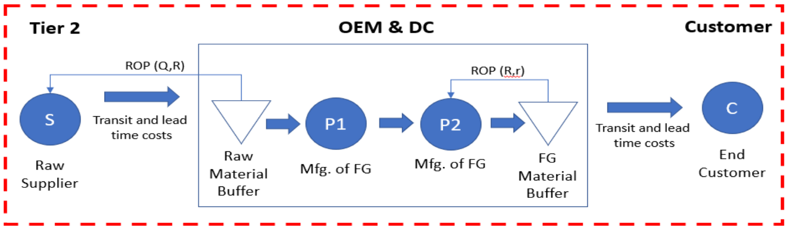

Figure 2: Redesigned and Complexity Reduced Model for Antibody Manufacturing.

3 SIMULATION MODEL AND RESULTS

The first step was the create a digital-twin of the complex antibody manufacturing and the supply chain. We used Arena Discrete-Event Simulation to model warehouse, distribution, manufacturing processes, and other processes necessary for the production of antibodies. In the next step we imported the data set. The data used to test the model were gathered from a global supply network and span one year. Finally, we ran multiple simulations for the base case, the complexity reduced model, and the sensitivity analysis.

The complexity reduction model led to a 38.2% total supply chain cost reduction. The biggest reduction is in the processing costs and in the inventory holding costs: the processing costs were reduced by 54.6% and the inventory holding costs were reduced by 26.7%. Moreover, the end-to-end lead times were reduced by 9.4%. A sensitivity analysis showed that these results are quite robust.

4 CONCLUSION

We provided a simulation model to reduce supply chain complexity within the regulated life science industry.

The results suggest that companies operating under such supply and production conditions should focus their attention on improving processing time and inventory holding costs. It was the first time that the organization involved utilized a digital twin to analyze the dynamic behavior of the antibody supply chain and to evaluate multiple scenarios within a short time frame.

The organization was extremely satisfied with the results and is planning to apply this approach to other settings.

REFERENCES

Li, F., N. Vijayasankaran, A. Shen, R. Kiss, and A. Amanullah, 2010. "Cell culture processes for monoclonal antibody production". *mAbs* 2(5): 466-479.

Steinwandter, V., D. Borchert, C. Herwig, 2019. "Data science tools and applications on the way to Pharma 4.0." *Drug Discovery Today* 24(9): 1795–1805.