A Plant Simulation approach for optimal resource utilization: A case study in the tire manufacturing industry

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ABSTRACT

In this study, the resource allocation and vital manufacturing processes in the tire manufacturing industry was comprehensively optimized. The paper deals in detail with the Banbury mixing process, which produces homogeneous rubber materials for tire components. In addition, the mixing process models were established by the Plant Simulation software to validate and compare scenarios and experiments with realistic production constraints. Discrete empirical distribution (dEmp) was proposed for population data. Various scenarios were created for different resource and process. Experiments were set as different group of compound set. Experiment manager was used as a tool to set up scenarios and the experiments to provide alternative results. The study results display the production time and machine utilization. The shortest production time of experiment results represents the best group of each scenario. As results, the scenario, which BB1 is changed from non-productive Banbury mixer to special Banbury mixer along with the normal process is combined with second special process, provides the suitable production volume which can reduce of total production time for 8.06 %. Our study provides a variety of the resource utilization of a Banbury mixing process and suggests an efficient optimization method for production performance improvement.

References

[1] Krajewski, L.J., Ritzman, L.P., Malhotra, M.K. (2013). *Operations management: Processes and supply chains*, 10th Edition, Pearson Education, London, United Kingdom.

[2] Wolniak, R., Skotnicka- Zasadzień, B., Gębalska-Kwiecień, A. (2018). Identification of bottlenecks and analysis of the state before applying lean management, In: *Proceedings of 12th International Conference Quality Production Improvement - QPI 2018,* Zaborze near Myszków, Poland, Article No. 01001, doi: 10.1051/matecconf/201818301001.

[3] Kokareva, V.V., Malyhin, A.N., Smelov, V.G. (2015). Production processes management by simulation in tecnomatix plant simulation, *Applied Mechanics and Materials,* Vol. 756, 604-609, doi: 10.4028/www.scientific.net/AMM.756.604.

[4] Fiľo, M., Markovič, J., Kliment, M., Trebuňa, P. (2013). PLM systems and Tecnomatix plant simulation, a description of the environment, control elements, creation simulations and models, *American Journal of Mechanical Engineering,* Vol. 1, No. 7, 165-168.

[5]   Zupan, H, Herakovic, N. (2015). Production line balancing with discrete event simulation: A case study, *IFAC-PapersOnLine,* Vol. 48, No. 3, 2305-2311, doi: 10.1016/j.ifacol.2015.06.431.

[6]   Borojevic, S., Jovisevic, V., Jokanovic, S. (2011). Modelling, simulation and optimization of process planning, *Journal of Production Engineering,* Vol. 12, No. 1, 87-90.

[7]   Zupan, H., Herakovic, N. (2015). Production line balancing with discrete event simulation: A case study, *IFAC-PapersOnLine,* Vol. 48, No. 3, 2305-2311, doi: 10.1016/j.ifacol.2015.06.431.

[8]   Kurkin, O., Šimon, M. (2011). Optimization of layout using discrete event simulation, *IBIMA Business Review,* Vol. 2011, Article ID 180343, doi: 10.5171/2011.180343.

[9]   Bangsow, S. (2010). Plant simulation, In: *Manufacturing simulation with plant simulation and SimTalk*, Springer, Berlin, Germany, 7-15, doi: 10.1007/978-3-642-05074-9_2.

[10] Ištoković, D., Perinić, M., Doboviček, S., Bazina, T. (2019). Simulation framework for determining the order and size of the product batches in the flow shop: A case study, *Advances in Production Engineering & Management,* Vol. 14, No. 2, 166-176, doi: 10.14743/apem2019.2.319.

[11] Arunkumar, Y., Patil, R., Mohankumar, S. (2012). Discrete event simulation for increasing productivity in digital manufacturing, *International Journal of Engineering Research and Development*, Vol. 1, No. 10, 36-40.

[12] Yang, S.L., Xu, Z.G., Li, G.Z., Wang, J.Y. (2020). Assembly transport optimization for a reconfigurable flow shop based on a discrete event simulation, *Advances in Production Engineering & Management,* Vol. 15, No. 1, 69-80, doi: 10.14743/apem2020.1.350.

[13] Li, G.Z., Xu, Z.G., Yang, S.L., Wang, H.Y., Bai, X.L., Ren, Z.H. (2020). Bottleneck identification and alleviation in a blocked serial production line with discrete event simulation: A case study, *Advances in Production Engineering & Management,* Vol. 15, No. 2, 125-136, doi: 10.14743/apem2020.2.353.

[14] Żywicki, K., Rewers, P. (2020). A simulation-based approach to study the influence of different production flows on manufacturing of customized products, *Advances in Production Engineering & Management,* Vol. 15, No. 4, 467-480, doi: 10.14743/apem2020.4.379.

[15] Ištoković, D., Perinić, M., Borić, A. (2021). Determining the minimum waiting times in a hybrid flow shop using simulation-optimization approach, *Tehnički Vjesnik – Technical Gazette,* Vol. 28, No. 2, 568-575, doi: 10.17559/TV-20210216132702.

[16] Rupnik, B., Kragelj, D., Šinko, S., Kramberger, T. (2020). Distributed energy resource operation analysis using discrete event-simulation, *Tehnički Vjesnik – Technical Gazette,* Vol. 27, No. 3, 860-867, doi: 10.17559/TV-20190626184415.

[17] Law, A.M. (2012). A tutorial on how to select simulation input probability distributions, In: *Proceedings of the 2012 Winter Simulation Conference (WSC),* Berlin, Germany, 1-15, doi: 10.1109/WSC.2012.6465281.

[18] Fishman, G.S., Kiviat, P.J. (1968). The statistics of discrete-event simulation, *Simulation,* Vol. 10, No. 4, 185-195, doi: 10.1177/003754976801000406.