Predictive Analytics of Stochastic Factors in Medium-Term Production Planning

S.A. Korolev[1], Bauman Moscow State Technical University, korolevsa@student.bmstu.ru

[1] Graduate Student, Moscow, Russia

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key words

predictive analytics, medium-term planning, stochasticity, order-based production, GAMLSS

This article develops an approach for the predictive analytics of stochastic factors in the medium-term planning of order-based mechanical engineering production. The study identifies key input parameters for planning and classifies them by their degree of uncertainty, focusing on those with strong stochasticity. The core problem addressed is the need to accurately estimate strongly stochastic parameters such as job labor intensity, spare parts demand, and equipment failure rates, given the limited historical data, which is typical for unique, low-repeatability order-based production. The research justifies the application of Generalized Additive Models for Location, Scale and Shape as a suitable tool. This approach allows for estimating not only the expected values but also the parameters of the probability distributions for these variables, enabling flexible risk management during planning. For each key stochastic factor, appropriate distribution families and sets of covariates are proposed. Labor intensity is modeled using the Beta distribution, spare part demand through a Weibull and subsequent Poisson — Weibull distribution, and equipment failure rates also via the Weibull distribution. The proposed predictive analytics models are computationally efficient, which allows to use it without a meaningful impact on the timing of planning process. The main limitation is the necessity of historical data, but the chosen model class is designed to work effectively with limited datasets. It is concluded that the proposed approach facilitates the creation of robust, risk-aware medium-term production plans.

References

1. Korolev S.A., *Nauka i biznes: puti razvitiya*, 2023, no. 1(139), pp. 26–30.
2. Erokhin E.A., Popov V.N., *Organizator proizvodstva*, 2011, no. 51(4), pp. 30–32.
3. Orlov A.I., *Politematicheskiy setevoy elektronnyy nauchnyy zhurnal Kubanskogo gosudarstvennogo agrarnogo universiteta*, 2013, no. 93, pp. 1–11.
4. Dobronets B.S., Kemel'baeva A.R. New approaches in regression analysis of ERS data, IX Int. sc. conf.: Regional problems of Earth remote sensing, Krasnoyarsk, 2022, pp. 97–100.
5. Stasinopoulos D. M., Rigby R. A., *Journal of Statistical Software*, 2007, vol. 23, no. 7, pp. 1–46. DOI: 10.18637/jss.v023.i07.
6. Brom A.E., Tret'yakova V.A., *Kompetentnost'*, 2023, no. 8, pp. 38–43. DOI: 10.24412/1993878020238-38-43.
7. Pashentsev A.I., Garmider A.A., Sulim S.N., etc, *Ekonomika stroitel'stva i prirodopol'zovaniya*, 2022, no. 3(84), pp. 130–137.
8. Korolev V.Yu., Korchagin A.Yu., Zeyfman A.I., *Informatika i ee primeneniya*, 2016, vol. 10, is. 4, pp. 11–20. DOI: 10.14357/19922264160402.
9. Romanov A.A., Timina I.A. Review of methods for assessing the labor intensity of production, IV Pospelov conf. with int. participation: Hybrid and synergetic intelligent systems, ed. by A.V. Kolesnikov, 2018, pp. 288–295.
10. Certificate of state registration of the computer program N 2025665563. The Russian Federation. Program for predictive assessment of stochastic input parameters of a medium-term plan for order-based production: decl. 30.05.2025; publ. 18.06.2025, S.A. Korolev, I.D. Sidel'nikov, A.E. Brom.