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*Tetyana Neroda, professor,
Institute of Printing Art and Media Technologies in Lviv Polytechnic*

DETERMINING PRIORITY FACTORS FOR PRINTING ORDER EXECUTION THROUGH BIG DATA PREDICTIVE ANALYTICS

The traditional printing industry is historically based on mass production principles, where economic viability is achieved through high-volume runs and extended pre-press cycles. Major printing enterprises focus on process stability and systematic capacity utilization to minimize unit costs through economies of scale. However, the modern market demands personalization and rapid turnaround, which has driven the development of on-demand printing networks [1].

Unlike traditional enterprises, the print-on-demand segment operates under conditions of high uncertainty regarding order volumes and specifications, which arrive in a continuous stream. Such production organization shifts the focus from the mechanical reproduction of identical copies to the management of agile workflows. Every operation in digital printing generates a significant volume of digital footprints: from input file parameters and user metadata to equipment logs and real-time energy consumption. The accumulation of these disparate data arrays forms a specific Big Data environment that, within rapid-response printing, encompasses the entire order lifecycle: from the moment of online cost estimation to the delivery of the finished print run. [2]. Static price lists fail to allow for an agile response to critical print queue overloads or, conversely, to equipment downtime during low-productivity hours. Therefore, there is a pressing need to rethink dynamic pricing mechanisms as a tool for automated demand regulation through cost. Such mechanisms must be based on the analysis of Big Data regarding current network load and the prioritization of lead times.

The collection and structuring of data arrays to determine order execution priority begins with Customer Relationship Management systems. These systems maintain a comprehensive communication history and record the primary input flow of requests, customer parameters, and the history of their interaction with the rapid-response printing network (Fig.1). It is precisely this data that enables the identification of consumer behavior patterns and seasonal demand fluctuations. The next level involves the integration of technical metrics from Raster Image Processors, which provide precise data on the resource intensity of layouts, alongside inventory management systems that reflect the real-time availability of consumables.

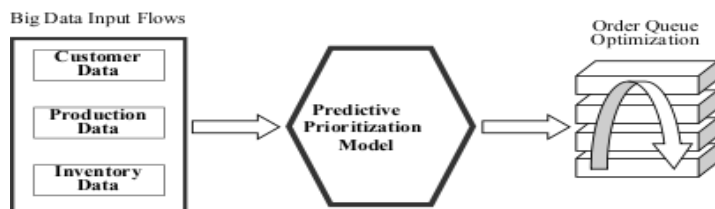


Figure 1. Generation of order execution priority based on multivariate data analysis

The comprehensive results derived from the analysis of these extensive Big Data arrays facilitate the construction of sophisticated predictive models for optimal distribution and scheduling of production queues, meticulously accounting for a complex set of deterministic factors. In this specific context, determination of order execution priority is fundamentally based on continuous, real-time synchronization of required lead times with current production line utilization and the immediate availability of necessary substrates and consumables. Should the data analysis indicate a critical deficit in available machine time or processing capacity, the system is designed to automatically identify and isolate orders possessing the highest importance coefficients. This automated intervention is crucial for maintaining the overall stability of technological cycle and preventing systemic bottlenecks.

Consequently, the proposed methodology ensures a strategic balance between the market demand for specific product types and the technical capability of the retail and production network to fulfill these orders within strictly regulated timeframes. The practical application of such predictive models, built upon accumulated historical and real-time data, significantly minimizes the operational risks of equipment overloads. Furthermore, it enables the network to respond with high flexibility to shifting market conditions through the sophisticated tools of dynamic pricing and value-based regulation. Future research trajectories are planned to focus on the engineering and design of a comprehensive analytical framework. This framework will be aimed at quantitatively evaluating and weighting the specific impact of each identified factor on the integrated operational efficiency of rapid-response printing networks.

List of sources used:

1. The Future of Digital Printing to 2032 : Market Report / Smithers. Akron : Smithers Information Ltd., 2022. 214 p.
2. Neroda T. Big data categorization in operational digital printing processes. Academic and University Science: Results and Prospect, Vol. 18, 2025. P. 207–209