DOI: https://doi.org/10.15276/hait.07.2024.16
UDC 004.9: 005.93

Information model for assessing the impact of tactical material procurement risks on order fulfillment in make-to-order manufacturing

Andrew L. Mrykhin[1)]
ORCID: https://orcid.org/0009-0009-1545-632X; amrykhin@gmail.com
Svitlana G. Antoshchuk[1)]
ORCID: https://orcid.org/0000-0002-9346-145X; asg@op.edu.ua. Scopus Author ID: 8393582500
[1)] Odesa Polytechnic National University, 1, Shevchenko Ave. Odesa, 65044, Ukraine

ABSTRACT

Manufacturing businesses are showing increased interest in the issue of supply risks for materials and components. In recent decades, numerous studies and reviews have been published on the subject of supply chain risks. However, most research examines the global impact of risks on business as a whole and proposes a multi-level procedure for identifying, assessing, and developing risk mitigation measures, which should be carried out in advance with the involvement of specialists and experts. Nevertheless in make-to-order manufacturing, it is important to assess the risks of material supply for individual production orders, at the same time taking into account constant changes in production state and supply chains. The problem of assessing the risks of material supply gets even more complicated at enterprises with a high mix of manufactured products. To solve the above-mentioned problems, the authors propose an automated model for risks evaluation. The model is implemented as a component of the enterprise's information system (ERP) and uses data from the technological, production, inventory, and logistics modules to calculate the probability of deviation in order fulfillment time from the planned schedule due to potential disruptions in material supply chains. When executing the model, it analyzes the production's material requirements in both volumetric and calendar terms, inventory levels, and the condition of supply channels. The risks of delayed delivery for each material are expressed as the standard deviation of the delivery date from the planned date and are calculated by composing the risks for segments (elements) of the supply chain, the risks for which are, in turn, calculated based on performance data accumulated in the logistics module, with the possibility of introducing correction coefficients and expert evaluations. The overall risk of order material supply is determined by summing up the delivery risks of individual materials, expressed as the corresponding standard deviations. The model's results can be used for managerial decision-making in production and procurement or for communicating expected order fulfillment times to customers. The model has been tested at an enterprise in the electrical engineering industry.

Keywords: Risk assessment; supply chain; material procurement; information model; enterprise resource planning

***For citation*: Mrykhin A. L., Antoshchuk S. G "Information model for assessing the impact of tactical material procurement risks on order fulfillment in make-to-order manufacturing". *Herald of Advanced Information Technology*. 2024; Vol.7 No.3: 243–252. DOI: https://doi.org/10.15276/hait.07.2024.16**

1. INTRODUCTION

The complexity and variety of products, globalization, and the spread of component outsourcing have increased the importance of supply chains for manufacturing companies in recent decades. At the same time, businesses have faced numerous disruptions in operations and financial losses due to destructive events in supply chains, leading to increased interest in the issue of risks in the supply of materials and components [1], [2].

Since the 1980s, numerous studies and reviews have been published on the analysis and management of supply chain risks, addressing the issue from the perspectives of economics, mathematics, and information technology. Most of these studies focus on the impact of risk on the business as a whole, its operational and financial results, and the development of long-term measures for risks avoidance or mitigation. However, for order-driven high-mix low-volume manufacturing, it is also important to analyze and evaluate the risks of materials and components procurement for individual manufacturing orders. Since the order is the main unit of operational management for such enterprises, and timely fulfillment of deadlines promised to the client is a key factor in customer satisfaction and loyalty [3].

High product variety usually also results in significant diversity in the materials used. As a result, the material bills for various orders can differ radically, as can the magnitude of the associated supply risks. Since the state of production environment and material supply channels is constantly changing, such order-based risk evaluation must be performed quickly and continuously, without the need to go through multi-stage formal procedures. Therefore, it is of interest to develop an automated model for evaluating the risks of material supply for individual production orders, integrated into the enterprise resource planning (ERP) system [4].

2. EXISTING APPROACHES, RESEARCH, PUBLICATIONS

In the groundbreaking study on procurement management in 1983 [5], Peter Kraljic proposed including risk assessment in his system of classification of purchased materials. However, until the late 1990s, discussion of risk assessment in supply chain studies was limited, mainly to the analysis of optimal inventory levels [6]. In 2000, George Zsidisin published the first comprehensive study of procurement risk management practices in nine American companies [6]. In 2003, Christine Harland suggested expanding the study of procurement risks to the entire supply chain and developed a structured framework for risk assessment and management [7]. That same year, Zsidisin proposed a scientifically grounded definition of procurement risk and a classification of its various aspects [8].

Following these initial publications, the number of studies on material supply risks and supply chain risks as a whole began to increase rapidly. In a 2021 review [9], Amulya Gurtu and Jestin John identified 455 publications on this topic over the ten years from 2010 to 2019. Various approaches to risk assessment have been proposed, both qualitative, such as ABC analysis, and quantitative, based on ratings, weights, or probability theory. Different frameworks for managing supply chain risks have been published. A standalone discipline of supply chain risk management (SCRM) has emerged [10]. Reviews of various approaches, methods, and risk management systems in supply chains can be found in [11], [12], [13] and [17].

Despite the variety of proposed systems, certain common features can be identified:

– a multi-stage risk management process: identific tion, analysis, assessment, response, often presented in a cycle similar to the Deming cycle. This process can be quite laborious and time-consuming, requiring regular involvement of specialists and experts with quality of assessment depending from their subjective views [14], [15];

– adoption of conception of risk realization as a consequence of relatively rare non-standard events (triggering events) that disrupt the normal functioning of business processes. Much effort is then put into identification, classification, tracing of these events, determining their probabilities and possible outcomes [16];

– the primary focus on the impact of risks on the overall business operation, financial performance, or operational stability. Often, risk analysis procedures are conducted only for strategic materials or the most critical suppliers [18], [6];

– thus, the models proposed within SCRM are mainly related to the strategic management of material supply risks, aiming to identify potential risks in advance and prepare countermeasures. Examples of such strategic risks include the catastrophic loss of unique production capacities (e.g., due to fire), bankruptcy of key suppliers, international sanctions, pandemics, and military actions.

3. THE PROBLEM OF TACTICAL RISKS

At the same time, there are always sources of smaller deviations in the process of supplying materials to production: transportation breakdowns, paperwork delays, congestion at transportation hubs, limited delays in shipment times by suppliers, etc. The authors think that in the discussed context it will be appropriate to call such risks tactical. For mass production to stock with a limited range of products, compensation for such risks is achieved through buffering and the implementation of practices like Just-in-Time [19], [20].

However, in order-driven production with a high variability of product range, the possibility of applying these techniques is limited. Use of buffering is possible and to some extent mandatory, but the extensive range of products and the short forecasting horizon for material requirements limit its applicability to only certain materials with a low demand/price ratio.

At the same time, for effective management of order-driven production, it is crucial to have up-to-date information on the status of each production order and the possibility of its completion within the planned timeframes. Therefore, the evaluation of tactical risks in the supply of materials for a specific order is as important as information on the state of production capacities and material stocks. Given the large number of orders in production and the rapid changes in supply channels, it is desirable that such evaluation can be carried out as automatically as possible, without multi-stage procedures and with minimal expert involvement.

Some ideas for the quantitative assessment of the risks of supplying specific materials are given in [21], Csanád Sipos in [22] proposes a model for risk

ISSN 2663-0176 (Print)
ISSN 2663-7731 (Online)

assessment based on material specifications of products. However, the model [22] relies on expert forecasts and assessments, and both models lack order-specific granularity and do not consider the current state of supply channels, making them more strategic than tactical in nature.

Interesting model of integration of procurement risks assessment with production scheduling was proposed by Tadeusz Sawik [23], but his research is focused on supplier selection and procurement cost optimization and relies on risk indexes determined outside of the model scope.

4. OBJECTIVES AND GOALS OF THE RESEARCH

In light of the above, the authors aimed to develop an information model that calculates the risks of material supply for production orders with a high degree of automation.

The key features of the proposed model should include:

– risk calculation primarily based on data available in the enterprise's ERP system, with minimal reliance on external sources that require manual processing, expert assessments, etc;

– timely updates of risk assessments in response to changes in production status and supply channels;

– the ability to generate quantitative risk assessments in a format that is clear and convenient for use by production managers, sales specialists, and material procurement personnel.

The risk assessment results obtained using the proposed model can be used to optimize the production plan, implement additional measures to ensure timely material delivery, or negotiate alternative order fulfillment deadlines with the customer.

The application of this model is primarily advisable for enterprises with make-to-order production and high variability in the product range. Its use can complement the process of managing strategic risks in supply chains or in the business as a whole.

5. GENERAL DESCRIPTION OF THE PROPOSED MODEL

Since aforementioned tactical risks usually manifest as intermittent limited deviations from the plan rather than rare destructive events, a convenient numerical measure of the risk of untimely order fulfillment can be the mean squared (standard) deviation of actual execution time from the planned time [24, 25], [26].

The risk of untimely production order fulfillment due to material supply disruptions is determined by summing the delivery risks of individual materials, expressed as the corresponding standard deviations:

$$Ro = \sqrt{\sum_{i=1}^{n} (Rm_i)^2}\ , \qquad (1)$$

where *Ro* is the risk of untimely order fulfillment, and Rm_i is the risk of untimely delivery of each material.

To determine the risks arising in the material supply chain, the chain is divided into a sequence of elements (segments) starting from the supplier who ships the material to its receipt at the enterprise's warehouse. For example: supplier's shipment, transport route section, transshipment or customs control point. Risk of untimely execution for each segment can be determined statistically (if there is sufficient data), by comparison with analogs, or through expert evaluation.

Then the risk of untimely delivery of each material is determined as the square root of the sum of the squares of the mean square deviations of the execution time of each incomplete segment of the chain:

$$Rm_i = \sqrt{\sum_{j=1}^{m} (Rs_j)^2}\ , \qquad (2)$$

where Rm_i is the risk of untimely delivery of the material, and Rs_j is the risk of delivery delays in each segment of the chain.

The risk of untimely delivery for a material available in the warehouse is assumed to be 0.

The model's implementation is assumed to be in the form of a service within the ERP system of the manufacturing enterprise. The service integrates with the modules of production planning, logistics, and material supply.

In the Manufacturing Planning and Control (MPC) module, the master production schedule (MPS) is developed, and based on it, the material specifications of products are exploded into the material requirements plan (MRP). The material specifications and the valid MPS are used by the model and are necessary for its operation.

In the Warehouse Management module, the receipt of materials and their issuance to production are tracked, and records of current inventory and materials allocation for planned production orders are kept, which are used by the model to calculate material deficit for individual production orders.

In the Materials Procurement module, the management of material supply orders is carried out, and their execution is monitored. These data serves as an input for the proposed model.

The Logistics module is designed for managing the transportation and transport operations of the enterprise, and it maintains a registry of segments (elements) of the supply chain, which is used by the model Fig. 1.

The main inputs of the model are:

– production operations assignments for order manufacturing from the MPS plan;

– records of material inventory and their reservations for existing orders;

– records of material supply orders in execution and their delivery routes as sequences of supply chain segments, including planned execution dates;

The model output is:

– risk of untimely order fulfillment as the standard deviation from the planned release date.

Scheme of model inputs and outputs is presented in Fig. 1.

In the proposed model, risks of on-time materials provisioning are calculated based on the risks of individual supply chain segments execution, retrieved from the supply chain segments registry of the ERP system.

An example of the supply chain segments registry is shown in Table 1.

The primary method for determining risks is statistical, as the standard deviation of actual segment execution results from the reference (planned) duration. The risk is recalculated after each segment execution based on the data from the logistics module. If actual data is insufficient to meet statistical reliability criteria (usually a certain number of actual segment executions over some time), the evaluation and calculations based on it are marked as doubtful. In case of insufficient or missing statistical data or information that significantly affects the reliability of the evaluation (e.g., closure of a checkpoint), the evaluations can be manually adjusted.

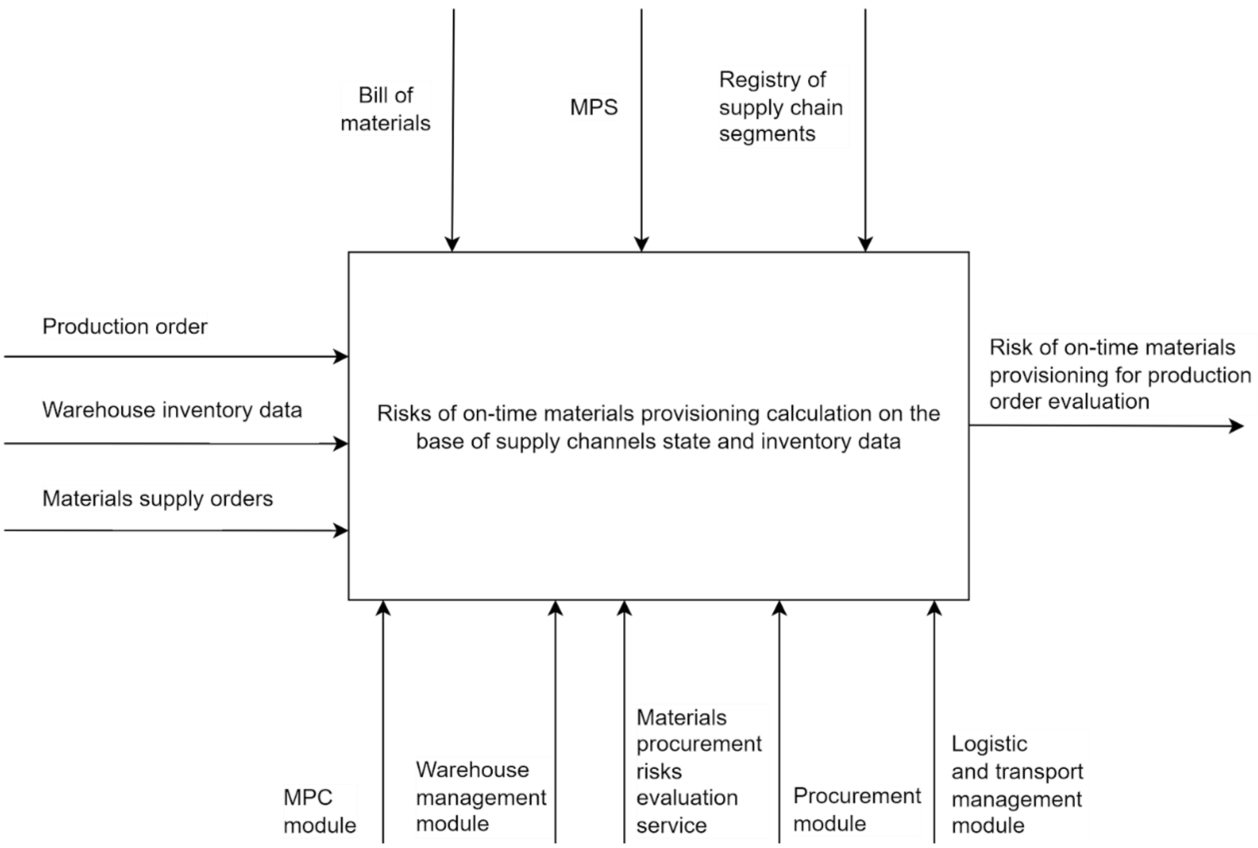

Fig 1. **Information model for assessing tactical supply risks**
***Source:* compiled by the authors**

ISSN 2663-0176 (Print)
ISSN 2663-7731 (Online)

Table 1. **Example of a supply chain segments registry**

Operation	Starting Point	Endpoint	Average Duration, Days	Standard deviation
Shipment by supplier		Lviv-Kat, Lviv	0	1.26
Transportation by road	Western Ukraine	Odesa	2	0.77
Shipment by supplier		Coarealis AG, Schwechat	0	0.45
Transportation by Road	Eastern Austria	Chopt Customs Point	2	0.77
Customs Clearance	Chopt Customs Point	Chopt Customs Point	1	1
Customs Clearance	Odesa	Odesa	1	0.45
Shipment by supplier		Daycho AMG, Qingdao	0	1
Transportation by sea	Qingdao Port	Port of Constanța	35	4.2
Transloading	Port of Constanța	Port of Constanța	1	0.45
Transportation by Road	Eastern Romania	Odesa	2	0.77
Shipment by supplier		Turkplas, Gebze	0	0.55
Transportation by Road	Western Turkey	Odesa	3	0.84

Source: **compiled by the authors**

5. MECHANISM OF MODEL OPERATION

The execution scheme of the model is shown in Fig. 2.

The calculation includes four stages:

1) MPS/MRP analysis;
2) material deficit calculation;
3) materials supply risks calculation;
4) annual risk of materials procurement for production order calculation;

Next, we will describe the implementation of each stage in detail using the example of risk calculation for an order to manufacture a specific product–an electric power cable.

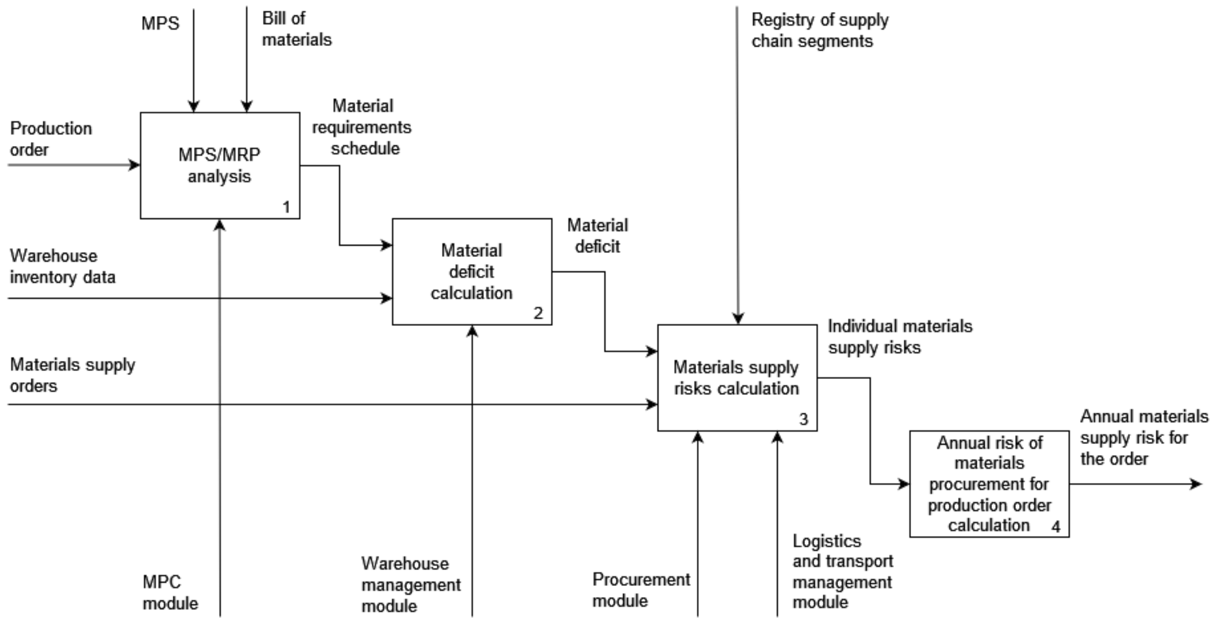

Fig 2. **Model execution stages**
Source: **compiled by the authors**

Let's review the implementation of the model using the example of calculating material supply risks for an order to manufacture VVG 3x2.5 power cable.

1. Operations for manufacturing the order are extracted from the MPS and transformed into the corresponding material requirements specification with due dates for materials provisioning attached. An example of the manufacturing plan and material requirements schedule are shown in Table 2 and Table 3;

2. For each material, available warehouse inventory (not reserved for any order or reserved for the evaluated order) is checked. The risk of material delivery, which is fully available in the warehouse, is assumed to be zero. In the example in Table 4, inventory covers only the need for sheath compound.

3. For materials not available or partially unavailable in the warehouse, the search for supply orders in execution is carried out. For ordered materials, the risk of untimely delivery is calculated as the sum of the standard deviations from the planned delivery duration for the supply chain segments whose execution is incomplete at the date of calculation. If, according to the manufacturing plan, the material is required later than the expected delivery date plus the standard deviation of the delivery time, the delivery risk is assumed to be zero. Otherwise, the material delivery risk equals the supply order execution risk minus the number of days between the need date and the expected delivery date. Supply risks for our example are shown in Table 5, Table 6, and Table 7. If the execution of any material supply orders for the examined product has not started (delivery route and schedule are not specified for supply order), a search for previous orders for the same material is carried out, and the risk of the last completed order is calculated and multiplied by an uncertainty coefficient determined by expert evaluation.

4. At the last, fourth stage, the risk of order non-fulfillment is calculated as the overall standard deviation of the order execution time from the planned time. The summary of material risks is presented in Table 8.

Table 2. **Product manufacturing plan**

Cable VVG 3x2.5		**Operation**	**Start date**
Quantity	50 km	Drawing	09.07.24
Planned production date	**18.07.24**	Conductors insulation	12.07.24
		Core twist	17.07.24
		Outer shell application	17.07.24

***Source*: compiled by the authors**

Table 3. **Material requirements schedule**

Material	**Unit**	**Required quantity**	**Requirement date**
Copper wire rod	kg	1800	09.07.24
Insulation Compound	kg	1200	12.07.24
Polyester threads	kg	5.2	17.07.24
Sheathing compound	kg	2200	17.07.24

***Source*: compiled by the authors**

Table 4. **Material inventory and deficit**

Material	**Unit**	**Required quantity**	**Available inventory**	**Deficit**
Copper wire rod	kg	1800	0	1800
Insulation Compound	kg	1200	800	400
Polyester threads	kg	5.2	0	5.2
Sheathing compound	kg	2200	7500	0

***Source*: compiled by the authors**

ISSN 2663-0176 (Print)
ISSN 2663-7731 (Online)

Table 5. **Order for the supply of copper wire rod**

Supplier: Lviv-kat, Ukraine Quantity: 20000 kg					
Segment name	**Starting point**	**Endpoint**	**State**	**Planned completion date**	**Standard deviation**
Shipment by supplier		Lviv-kat, Lviv	Planned	07.07.24	1.26
Transportation by road	Western Ukraine	Odesa	Planned	09.07.24	0.77
Overall standard deviation					**1.48**

***Source*: compiled by the authors**

Table 6. **Order and risks of supplying insulation compound**

Supplier: Coarealis AG, Austria Quantity: 10000 kg					
Segment name	**Starting point**	**Endpoint**	**State**	**Planned completion date**	**Standard deviation**
Shipment by supplier		Coarealis AG, Schwechat	Done	05.07.24	0
Transportation by road	Eastern Austria	Checkpoint Chop	Done	07.07.24	0
Customs clearance	Checkpoint Chop	Checkpoint Chop	Performed	09.07.24	1
Transportation by road	Western Ukraine	Odesa	Planned	11.07.24	0.77
Overall standard deviation					**1.26**

***Source*: compiled by the authors**

Table 7. **Order and risks of supplying insulation compound**

Supplier: Daycho AMG, China Quantity: 500 kg					
Segment name	**Starting point**	**Endpoint**	**State**	**Planned completion date**	**Standard deviation**
Shipment by supplier		Daycho AMG, Qingdao	Done	05.06.24	0
Transportation by sea	Port Qingdao	Port Constanta	In progress	12.07.24	4.2
Transloading	Port Constanta	Port Constanta	Planned	13.07.24	0.45
Transportation by road	Eastern Romania	Odesa	Planned	15.07.24	0.77
Customs clearance	Odesa	Odesa	Planned	16.07.24	0.45
Overall standard deviation					**4.32**

***Source*: compiled by the authors**

Table 8. **Summary table of material supply risk for order**

Material	Deficit	Date of Requirement	Planned Date of Receipt	Standard Deviation of Receipt Date	Delivery risk of material
Copper wire rod	1800	09.07.24	09.07.24	1.48	1.48
Insulation Compound	400	12.07.24	11.07.24	1.26	0.26
Polyester threads	5.2	17.07.24	16.07.24	4.32	3.32
Sheathing compound	0	17.07.24	-	0	0
Overall risk of supplying materials for the order					**3.64**

Source: compiled by the authors

As a result of the model execution, the risk of materials procurement for the production order was calculated, expressed as the standard deviation from the production date. For the presented example the risk is 3.64 days (Table 8).

Here are some examples of possible management decisions based on this information:

– having agreed with the client on the cable shipment date of 07.30.24, the sales manager can count on that this date will be met with high reliability;

– if it is necessary to guarantee the shipment of the cable at an earlier date, the sales department management may require the replacement of the polyester threads that make the main contribution to the supply risks with a more expensive material that is promptly available from a local supplier;

– conversely, if the shipment date is not critical, the production department can shift production operations to a later time, into an area of lower material supply risks, freeing up equipment for other work.

6. CONCLUSION

The process of automated risk evaluation implemented in the proposed model, combined with integration into the enterprise resource management system, ensures continuous availability of up-to-date information on tactical material procurement risks for every order in production.

During pilot operation at one of the enterprises in the electrical industry, the model provides real-time calculation of material supply risks for up to 2000 concurrently manufactured order items with a total number of used material types exceeding 800. The company’s employees use the model both as a “red flags” system for the timely identification of problematic orders and as a source of data for decision-making when communicating with customers and updating the master production schedule.

The above gives reason to believe that the proposed model will become an effective and unobtrusive tool in the set of means for managing make-to-order production.

Further research plans include continuing to collect statistics on the model's performance results, in particular, refining the nature of risk distributions for various types of segments. The obtained data is planned to be used to optimize the model algorithms and improve recommendations for using the results in production management. Adapting the proposed approach to assess other production risks, such as those related to the availability of production equipment, may also be of interest.

REFERENCES

1. Zsidisin, G. & Henke, M. “Research in supply chain risk: Historical roots and future perspectives”. *Revisiting Supply Chain Risk. Springer Series in Supply Chain Management*. Springer, Cham. 2019; 7: 1–12. DOI: https://doi.org/10.1007/978-3-030-03813-7_1.

2. Nel, J. “The role of supply chain risk mitigation strategies to manage supply chain disruptions.” *Journal of Transport and Supply Chain Management.* 2024; 18. DOI: https://doi.org/10.4102/jtscm.v18i0.1035.

3. Gan, Z. L., Musa, S. N. & Yap, H J. “A review of the high-mix, low-volume manufacturing industry.” *Applied Sciences*. 2023; 13 (3): 1687. DOI: https://doi.org/10.3390/app13031687.

4. Kunneke, K. & Niemann, W. "Supply chain risk management capabilities during enterprise resource planning implementation: Perspectives of enterprise resource planning providers and their clients". *Journal of Contemporary Management*. 2024; 21: 47–84. DOI: https://doi.org/10.35683/jcman1061.240.

5. Kraljic, P. "Purchasing must become supply management". *Harvard Business Review*. 1983.

6. Zsidisin, G., Panelli, A. & Upton, R. "Purchasing organization involvement in risk assessments, contingency plans, and risk management: An exploratory study". *Supply Chain Management: An International Journal*. 2000; 5: 187–198. DOI: https://doi.org/10.1108/13598540010347307.

7. Harland, C., Brenchley, R. & Walker, H. "Risk in supply networks". *Journal of Purchasing and Supply Management*. 2003; 9: 51–62. DOI: https://doi.org/10.1016/S1478-4092(03)00004-9.

8. Zsidisin, G. "A grounded definition of supply risk". *Journal of Purchasing and Supply Management*. 2003; 9: 217–224. DOI: https://doi.org/10.1016/j.pursup.2003.07.002.

9. Gurtu, A. & Johny, J. "Supply chain risk management: Literature review". *Risks*. 2021; 9 (1): 16. DOI: https://doi.org/10.3390/risks9010016.

10. Schlegel, G. & Trent, R. "Supply chain risk management: An emerging discipline". *CRC Press*. 2014. DOI: https://doi.org/10.1201/b17531.

11. Heckmann, I., Comes, T. & Nickel, S. "A critical review on supply chain risk – definition, measure and modeling". *Omega*. 2014; 52. DOI: https://doi.org/10.1016/j.omega.2014.10.004.

12. Fan, Y. & Stevenson, M. "A review of supply chain risk management: Definition, theory, and research agenda". *International Journal of Physical Distribution & Logistics Management*. 2018; 48. DOI: https://doi.org/10.1108/IJPDLM-01-2017-0043.

13. Khojasteh-Ghamari, Z. & Irohara, T. "Supply chain risk management: A comprehensive review". *In: Khojasteh, Y. (eds) Supply Chain Risk Management*. Springer, Singapore. 2018. DOI: https://doi.org/10.1007/978-981-10-4106-8_1.

14. Zsidisin, G., Gaudenzi, B. & Pellegrino, R. "Strategic sourcing: Approaches for managing supply chain risk". *Strategic Sourcing*. 2024. DOI: https://doi.org/10.1007/978-3-031-52592-6.

15. Hubbard, D. "The failure of risk management". 2nd ed. 2020. ISBN: 978-1-119-52203-4.

16. Wagner, S. & Bode, C. "Dominant risks and risk management practices in supply chains". 2009. DOI: https://doi.org/10.1007/978-0-387-79934-6_17.

17. Cooper, M. "Building resilient supply chains: Perspectives on procurement risk management". 2024. DOI: https://doi.org/10.20944/preprints202407.0609.v1.

18. Parast, M. & Shekarian, M. "The Impact of supply chain disruptions on organizational performance: A literature review." 2019; 7. DOI: https://doi.org/10.1007/978-3-030-03813-7_21.

19. Anaba, D. & Kess-Momoh, A. & Ayodeji, S. "Optimizing supply chain and logistics management: A review of modern practices". *Open Access Research Journal of Science and Technology*. 2024; 11: 20–28. DOI: https://doi.org/10.53022/oarjst.2024.11.2.0083.

20. Choi, T. & Netland, T. & Sanders, N. & Sodhi, M. & Wagner, S. "Just in time for supply chains in turbulent times." *Production and Operations Management*. 2023; 32 (7): 2331–2340. DOI: https://doi.org/10.1111/poms.13979.

21. Takata, S. & Yamanaka, M. "BOM based supply chain risk management". *CIRP Annals – Manufacturing Technology*. 2013; 62: 479–482. DOI: https://doi.org/10.1016/j.cirp.2013.03.039.

22. Sipos, C. & Szűcs, E. "Supplier risk assessment strategy". *International Review of Applied Sciences and Engineering*. 2021; 13: 208–215. DOI: https://doi.org/10.1556/1848.2021.00350.

23. Sawik, T. "Integrated selection of suppliers and scheduling of customer orders in the presence of supply chain disruption risks". *International Journal of Production Research*. 2013; 51 (23–24): 7006–7022. DOI: https://doi.org/10.1080/00207543.2013.852702.

24. Taschner, A. & Charifzadeh, M. "Risk management in supply chains". *In: Management Accounting in Supply Chains. Springer Gabler, Wiesbaden*. 2023. DOI: https://doi.org/10.1007/978-3-658-41300-2_7.

25. Mackenzie, C. "Summarizing risk using risk measures and risk indices". *Risk Analysis: an Official Publication of the Society for Risk Analysis*. 2014; 34: 2143–2162. DOI: https://doi.org/10.1111/risa.12220.

26. Rudnichenko, N., Vychuzhanin, V., Otradskya, T., Shvedov, D. "Intelligent system for processing and forecasting financial assets and risks". *CMIS-2024 Computer Modeling and Intelligent Systems*. Ceur-ws.org. 2024; Vol-3702: 251– 262.

Conflicts of Interest: the authors declare no conflict of interest

Received 05.08.2024
Received after revision 16.09.2024
Accepted 21.09.2024

DOI: https://doi.org/10.15276/hait.07.2024.16
УДК 004.9: 005.93

Інформаційна модель оцінки впливу оперативних ризиків постачання матеріалів на виконання замовлень у позамовному виробництві

Мрихін Андрій Львович[1)]
ORCID: https://orcid.org/0009-0009-1545-632X; amrykhin@gmail.com
Svitlana G. Antoshchuk[1)]
ORCID: https://orcid.org/0000-0002-9346-145X; asg@op.edu.ua. Scopus Author ID: 8393582500
[1)] Національний університет «Одеська політехніка», пр. Шевченка, 1. Одеса, 65044, Україна

АНОТАЦІЯ

Виробничі бізнеси проявляють підвищений інтерес до проблеми ризиків постачання матеріалів та компонентів, що стимулює увагу наукової спільноти до цієї теми. Упродовж останніх десятиліть опубліковано численні дослідження та огляди, присвячені темі ризиків у постачанні матеріалів. Проте більшість досліджень розглядають глобальний вплив ризиків на бізнес загалом і пропонують багаторівневу процедуру ідентифікації, оцінки та розробки заходів протидії ризикам, яку слід проводити заздалегідь із залученням широкого кола фахівців. Водночас у позамовних виробництвах важлива оцінка ризиків забезпечення матеріалами окремих конкретних виробничих замовлень у поєднанні з оперативним реагуванням на постійно змінюваний стан виробництва та каналів постачання. Проблема оцінки ризиків постачання матеріалів ускладнюється на підприємствах із великою номенклатурою вироблюваних виробів. Для вирішення вищенаведених проблем авторами пропонується автоматизована модель оцінки ризиків. Модель реалізується як компонент інформаційної системи підприємства і використовує дані технологічного, виробничого, складського, логістичного модулів для розрахунку ймовірності відхилення терміну виконання замовлення від планового внаслідок ймовірних порушень у ланцюгах постачання матеріалів. Під час виконання моделі здійснюється аналіз потреби виробництва в матеріалах в об'ємному та календарному вираженні, складських залишків та стану каналів постачання матеріалів. Ризики несвоєчасного постачання кожного з матеріалів виражаються середньоквадратичним відхиленням дати доставки від планової і розраховуються шляхом композиції ризиків для сегментів (елементів) ланцюга постачання, ризики для яких, у свою чергу, обчислюються на основі даних виконання, накопичених у логістичному модулі з можливістю введення коригуючих коефіцієнтів і експертних оцінок. Загальний ризик забезпечення замовлення матеріалами визначається шляхом підсумовування ризиків постачання окремих матеріалів, виражених відповідними середньоквадратичними відхиленнями. Результати моделі можуть бути використані для прийняття управлінських рішень з управління виробництвом і постачанням матеріалів або комунікації замовникам очікуваних термінів виконання замовлень. Модель пройшла апробацію на одному з підприємств електротехнічної галузі.

Ключові слова: оцінка ризиків; ланцюги постачання; інформаційна модель; планування ресурсів підприємства

ABOUT THE AUTHORS

Andrew L. Mrykhin - Postgraduate student, Department of Information Systems. Odesa Polytechnic National University, 1, Shevchenko Ave. Odesa, 65044, Ukraine
ORCID: https://orcid.org/0009-0009-1545-632X; asg@op.edu.ua.
***Research field*:** Information systems for manufacturing planning and control

Мрихін Андрій Львович – аспірант кафедри Інформаційних систем. Національний університет «Одеська політехніка», пр. Шевченка, 1, Одеса, 65044, Україна

Svitlana G. Antoshchuk - Doctor of Engineering Sciences, Professor, Department Information Systems. Odesa Polytechnic National University, 1, Shevchenko Ave. Odesa, 65044, Ukraine
ORCID: https://orcid.org/0000-0002-9346-145X; asg@op.edu.ua. Scopus Author ID: 8393582500
***Research field*:** Automated management systems and progressive information technologies; information technology; theoretical and applied aspects of multimedia data processing

Антощук Світлана Григорівна – доктор технічних наук, професор кафедри Інформаційних систем. Національний університет «Одеська політехніка», пр. Шевченка, 1, Одеса, 65044, Україна