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## **SYSTEM OF PRODUCTION ORDER VERIFICATION IN APPLICATION TO SERVICE OF CUSTOMER**

### **Abstract**

*In this paper the efficiency of the System of Production Order Verification in application to service of customer is examined. Its aim is to find out whether a given work order can be accepted to be processed in an enterprise and satisfy the customer's requirements within constraints imposed by the enterprise configuration and the process of manufacturing of other products. The presented system is illustrated on an example.*

### **1. INTRODUCTION**

Strong competition brings about an increase in customers' demands. Customers expect a quality improvement, an increment in offered assortment, shortening of production cycle and a reduction in price. Enterprises must adapt their products to individual customers' needs. Small companies producing short batches of products are particularly capable of accepting the challenge.

Customers need not only best quality products, but also a customer services improvement. During their first visit to the Customer Service Department, customers already expect to be informed on what chances there are for their orders to be carried out in the producer's production system. For this reason producers are forced to use computer aided systems.

In practice, the most commonly used systems, especially in large enterprises, are Enterprise Requirements Planning (ERP) systems. The most often used optimization and simulation methods or expert systems are too expansive for small business, particularly the costs of implementation and maintenance. Moreover, their operation is too laborious and time-consuming to be used in customer service [2], [3]. Thus, smaller enterprises search for systems that would be cheap, capable of estimating production capacity and production costs of an order and checking financial resources in online mode.

The paper proposes a computer aided system for verification of production orders called "The System of Production Orders Verification (SPOV)". The presented concept provides an alternative to currently used workflow management methods. This system, contrary to other systems, can be applied in Customer Service Departments. Such an approach enables the user - in online mode – at arriving at an instant answer to the following question: Can a new order

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submitted for realization be accepted and what is the production cost [4], [5], [7]? The potential of SPOV is demonstrated with an illustrative example.

## **2. PROBLEM AREA AND ITS DESCRIPTION**

There is a given production system and a set of production orders planned to be executed. The production system is characterized by limitations such as: the availability of workstations and employees, workplace stores (buffers) capacity, transportation system capacity (conveyors capacity), and the availability of financial resources. The availability of resources is variable in time. Other production orders are currently being executed in the system. Products are made only on the basis of production orders. The production orders are characterized by given customers' needs, such as the size of a production order, workflow, order realization time and the maximum price. The producer has no influence on the workflow of orders submitted for realization. It is essential to find out whether a given production order can be accepted and executed in due time and in limited financial conditions. The answer must be provided in online mode.

The verification of production orders can be employed in Customer Service Departments only when the producer has received information about financial limitations of production orders realization. It is essential to know the planned production cost of the order realization. Furthermore, the producer must know whether the financial resources are sufficient in every time unit of expenses (especially in case of unit and small batch production).

To conclude, a computer aided system is searched which can:

- estimate the production capacity of a production system,
- calculate planned order processing cost,
- examine the financial resources available for the execution of a production order in the given time frame.

## **3. THE METHOD SPECIFICATION**

The paper proposes a method of checking sufficient conditions. This method employs a set of sufficient conditions, fulfillment of which guarantees the execution of a new production order on time and in limited financial conditions. There is considered a planned horizon, which stretches from the moment an order is submitted for realization to the realization time determined by customer [6], [8].

In that context the approach proposed can be seen as one following the Goldratt's Theory of Constrains (TOC) [1]. It means, a set of admissible solutions contains the production flows following local constraints imposed by buffers capacity, transportation means capacity, makespan, assumed cost, and so on. So, a conjunction of above mentioned constraints provides a constraint that can be treated as a bottleneck in the TOC approach. An idea of the method considered assumes, however, a step by step (i.e. local constraint by local constraint) refinement of the final set of admissible solutions.

The application of the method under discussion results in a set of production batch sizes limited by following sufficient conditions (Fig. 1.):

- production capacity,
- transportation capacity,
- buffer capacity,

- time limit,
- maximum price.

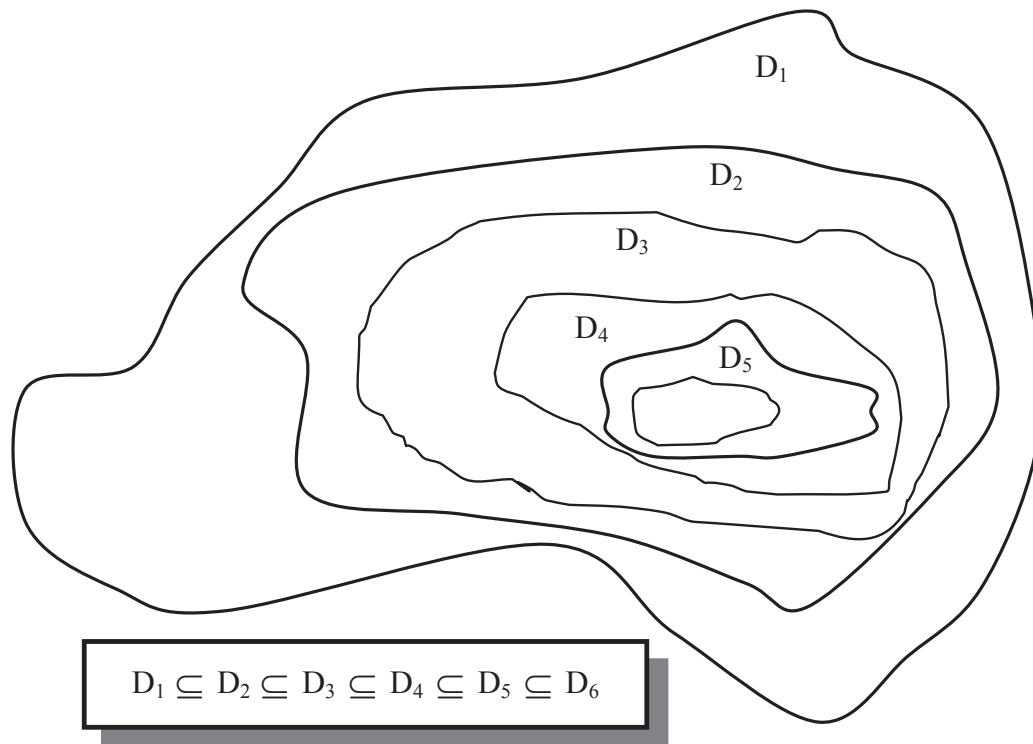


Fig.1. The limitations on the set of production batch sizes

#### 4. AN ILLUSTRATIVE EXAMPLE

A practical application of the proposed procedure is a computer aided system called “System of Production Order Verification” (SPOV). This example shows how the availability of financial resources is examined in SPOV. There is a production system. Currently, some orders are being executed in the system. It is assumed that the economic conditions of the enterprise are known. Thus, there is a new production order planned to be carried out. Now it is essential to find out what production batch size guarantees the execution of the planned production order using only the company’s own financial resources.

In the case under discussion, the production system consists of five stations ( $S_1, S_2, S_3, S_4, S_5$ ). Each station has one buffer with definite capacity ( $B_1, B_2, B_3, B_4, B_5$ ). The capacity of each buffer equals five units. Each station is characterized by a definite station cost ( $K_{jst}$ ) and set up cost ( $K_{j pz}$ ). This data is fed into SPOV – Fig. 2.

One employee operates one station. There is a central store  $C$  with unlimited capacity. The raw material and final goods are stored in it. Technological resources are connected by conveyors. After processing the raw material is moved direct by a conveyor from the order’s technological itinerary to the buffer of the next station or central store. The transportation time between stations amounts to one unit of the system work time. The itinerary of conveyors and transportation times are presented in Fig. 3.

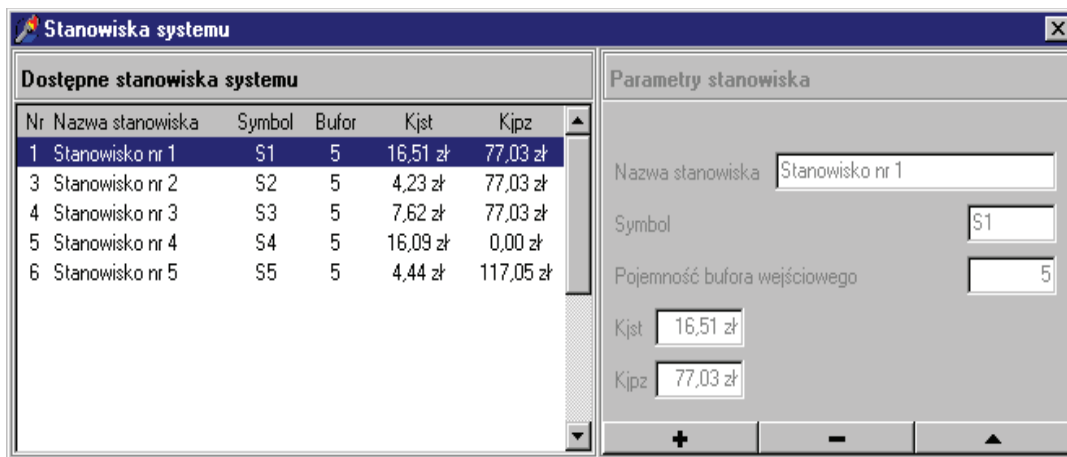


Fig.2. The specification of stations

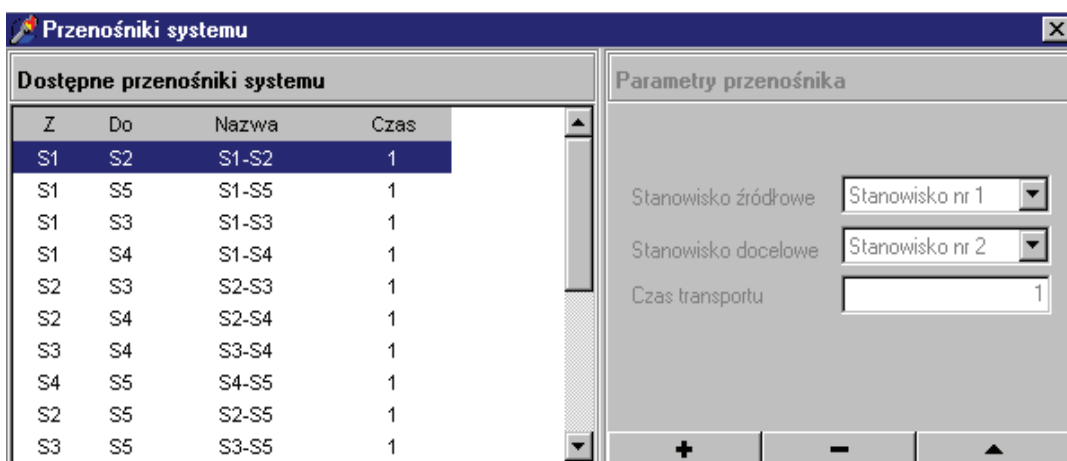


Fig.3. The itinerary of conveyors and transportation times between stations

At the moment, two production orders are being executed in the system:  $Z_1$  and  $Z_2$ . The order  $Z_3$  with given time is planned to be introduced to the system. The production order  $Z_1$  is specified by process  $P_1$  (Tab. 1). The production order  $Z_2$  is specified by process  $P_2$  (Tab. 2). The production order  $Z_3$  is specified by process  $P_3$  (Tab. 3).

The production program is illustrated in Tab. 4. The data for the production orders are introduced to the SPOV .

Tab.1. Process  $P_1$

Number of process $P_1$	1	2	3
Station	$S_1$	$S_2$	$S_4$
Set up time (in units)	1	2	0
Operation time	1	3	5

Tab.2. Process P<sub>2</sub>

Number of process P <sub>2</sub>	1	2	3
Station	S <sub>1</sub>	S <sub>3</sub>	S <sub>5</sub>
Set up time (in units)	1	1	1
Operation time	1	2	2

Tab.3. Process P<sub>3</sub>

Number of process P <sub>3</sub>	1	2	3
Station	S <sub>2</sub>	S <sub>3</sub>	S <sub>5</sub>
Set up time (in units)	1	2	1
Operation time	2	2	2

Tab.4. The production program

Number of production order	Number of operation in process	Volume of output	Maximum price	Time limit
Z <sub>1</sub>	3	100	23 500	600
Z <sub>2</sub>	3	120	31 000	3500
Z <sub>3</sub>	3	50	50 000	4200

It is assumed that the customer determines the time limit for a production order and the maximum price. A planning horizon is considered. It stretches from the moment an order is submitted for realization to the realization time determined by the customer.

The cash income and expense plan forms the basis for determining the availability of financial resources and credit capacity of the company in the given planning horizon. This information is shown in Fig. 4. The unit of the availability of financial resources is a day.

Dzień	Dostępne zasoby finansowe
1	206 432,34 zł
4	201 474,44 zł
15	183 494,33 zł
16	187 333,39 zł
23	126 333,65 zł
39	92 829,54 zł
53	73 833,83 zł

Liczba jednostek harmonogramu na jeden dzień:

Zdolność kredytowa:

Zapisz

Fig.4. The availability of financial resources and credit capacity of the company

The data on costs is fed into the SPOV – Fig. 5. The cost rates are set by means of the Activity Based Costing method. This data is based on last accounting period.

Nazwa kosztu	Koszt jednostkowy
Projektowanie	2,73 zł
Przygotowanie produkcji	2,27 zł
Zaopatrzenie	3,62 zł
Magazynowanie	4,90 zł
Transport wewnątrzzakładowy	2,86 zł
Koszt jednostkowy robocizny bezpośredniej	4,00 zł
Koszt jednostkowy pozostałych kosztów bezpośrednich	1,50 zł

Fig.5. The cost rates

When the data on the production system and the new production order has been fed into the SPOV, the verification of production order  $Z_3$  begins. The result of the verification is a set of solutions – a set of production batch sizes  $\{1,2,3\}$  – Fig. 6. The SPOV determines the time of production order realization and the planned production cost for each production batch size in the set.

The SPOV examines considers three variants of the availability of financial resources. First, it looks into the realization of the new production order exploiting only the company's own financial resources (variant 1). If the own financial resources are sufficient, variant 2 and 3 are not examined and the value of the planned production cost in the remaining variants equals 0. The SPOV shows the production cost as in Fig. 6.

Dopuszczalne wielkości partii zlecenia						
Wielkość partii	Termin realizacji	Zasoby własne	Zdolność kredytowa		Zaliczka	
		Koszt realizacji	Koszt realizacji	Wysokość zaliczki	Koszt realizacji	Wysokość zaliczki
1	1299	21643.50	0.00	0.00	0.00	0.00
2	676	12662.08	0.00	0.00	0.00	0.00
3	476	9787.60	0.00	0.00	0.00	0.00

Fig.6. The set of production batch sizes, production time and cost of a planned production order

However, if the company's own financial resources are insufficient to cover the realization of the planned production order, the remaining variants (variants 2 and 3) are looked into. Variant 2 assumes that the execution of the production order is covered partly by the company's own resources and partly by a bank credit. Variant 3 involves an advanced payment

for the customer's part. Employing two variants improves customer service. Variant 2 is more expensive for the customer. Variant 3 is cheaper but requires customers to use their own money.

The SPOV system provides a considerable amount of information on a production order planned for execution, and constitutes a ready workflow schedule for a set of production batch sizes (Fig. 7).

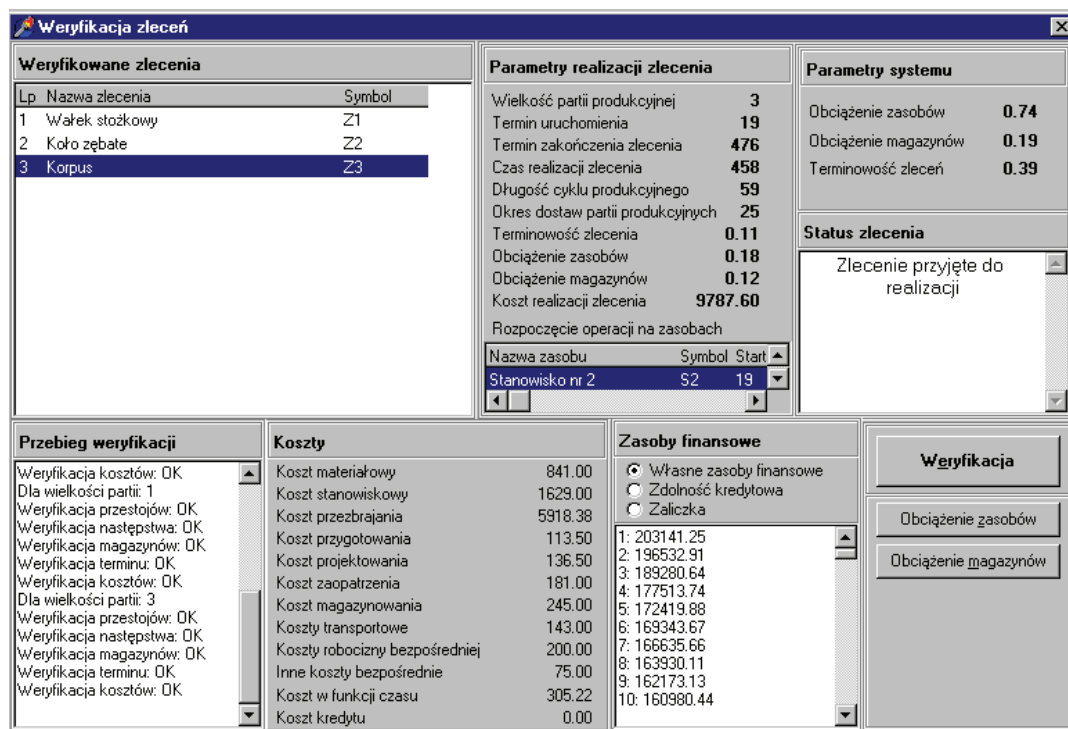


Fig.7. The result of production order verification with production batch size 3

In conclusion, on the basis of the presented verification it has been established that  $Z_3$  can be executed in the system. The application of  $b_3=1$ ,  $b_3=2$  and  $b_3=3$  batch sizes guarantees the order realization in due time.

The presented approach results in a workflow schedule for a set of production batch sizes, each of which guarantees order realization in due time. If the set is empty, it means the order realization exceeds the assigned time. The verification described in the paper is helpful in arriving at a decision during price negotiation.

## 5. CONCLUSIONS

The paper presents the production orders verification which enables the producer at arriving at an instant answer to the question whether a new production order can be executed in the system. The discussed method respects the customer's requirements and the limitations of the production system. It helps to make a decision on a planned order realization. It provides basis for price negotiations. The result of the approach outlined in the paper is a workflow schedule for a set of production batch sizes, each of which guarantees order realization in due time.

The paper focuses on the practical application of the SPOV in searching for a solution to the problem of an instant query about the possibilities for realization of the planned production order in the system.

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