# The Concept for the Design of Production Logistics Networks of Small and Medium-Sized Enterprises

Sebastian Saniuk
*University of Zielona Gora, Poland*

The study attempts to identify the problem of designing those logistics networks that cooperate with each other for small and medium-sized enterprises considering the limits of resources and logistics networks. The primary objective of the paper is to develop rapid prototyping methodology of the admissible variants of the network of cooperating companies to ensure timely implementation of the new production order.
**Key words:** design, supply chain, production logistics.

## 1. INTRODUCTION

Dynamic changes caused by high assortment variability and short deadlines create the need of effective implementation of the exchange between companies. On the present production market we can notice the focus for specialization, high assortment variability, product life cycle shortening, continuous quality improvement, reduction of production costs, etc. The reason for the observed trend is caused mostly by strong competition between companies, which requires innovation and an improved customer orientation [4].

Due to the high requirements established for the manufacturers and the capabilities of modern networks a company cooperation development implementing joint projects in the so-called logistics networks can be noticed. The idea of production within a logistics network means simply the joint production. The companies share their spare capacities which are necessary to produce the type of product [2], [9]. This solution gives the possibility to a group of specialized companies to carry out an order in case, where it exceeds the capabilities of each of them individually.

Modern supply chains are the result of companies cooperation aimed at the use of the synergies effect improving the performance of global production. This means shorter delivery times to customers, reduced inventory throughout the supply chain, reducing the cost of order, the quest for effective customer service, etc. In comparison with the classic logistics chain the horizontal structure layout is extended. Theoretically it is possible to create a vast network of suppliers, manufacturers, distributors and customers, which allows all participants an optimization of their costs, inventory and system load[1].

The need to respond to change, temporality and volatility of projects causes that the modern supply chains are considered as a permanent change management. The need to adjust to volatility is the reason for rebuilding the means of logistic processes and the use of adaptive management [3] that is able to adapt to the processes of material flow to the features of enterprises network, infrastructure, logistics, customer expectations, etc.

A common problem is to asses the feasibility of new production business (production order), which can be completed on time, assuming that the there is a system of cooperating enterprises, equipped with the combined capacity and the appropriate transport system [8].

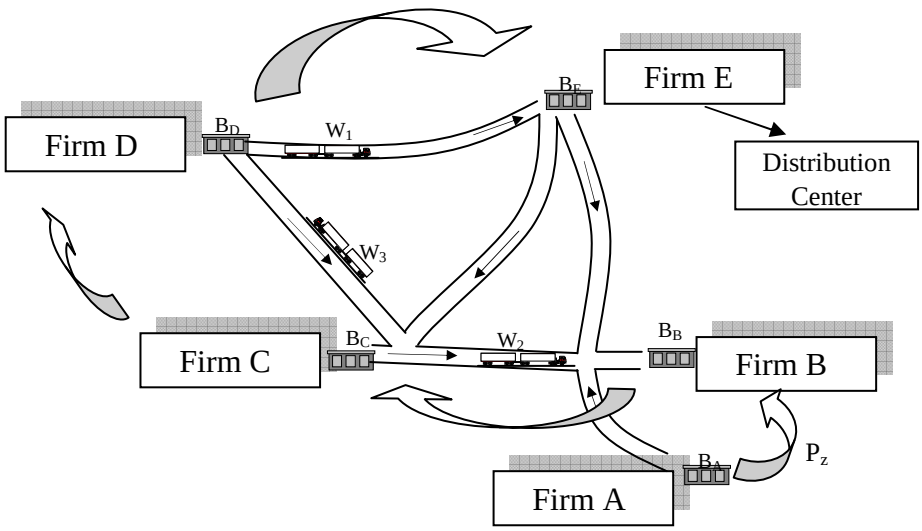
Determination of variants of possible solution for implemented production processes is associated with the need to solve the problem of high combinatorial complexity. Known and used methods in solving similar problems, in particular, optimization methods, are highly time-consuming, and require a lot of work and cause high costs. The presently used system APS (Advanced Planning System) also generates a lot of problems, especially at the operational level [6]. Using these methods makes it difficult to find a solution to put them online. Hence the need for research, implementation of methods and systems for the rapid generation of acceptable alternatives to implement the planned order in terms of logistical constraints.

## 2. LOGISTICS NETWORK PRODUCTION MODEL

In our case we are dealing with a set of small and medium-sized production companies with a narrow specialization who have spare capacity, a set of transport companies operating in the communication system (Fig. 1). Known limitations are as follows: production capacity of enterprises (type, period of availability, cost of resource utilization), topology of the routes (land, sea, air), means of transport (number, capacity, travel times and costs), storage capacities of enterprises.

The project is implemented within the network of geographically dispersed enterprises and an available transport system. The order can be characterized with planned volume production, the required date of its completion and implementation costs (the price). Method of execution of the order is described by the production process Pz = (P1, P2, ..., Pi), which is a vector, whose elements define the sub-processes executed in different enterprises.

Generally the problem in this type of systems can solved by answereing the following question: Is there a network of companies able to execute orders in a given time horizon and projected costs?




Legend:
Firms A, B, C, D, E – enterprises which execution process $P_z$;
$B_A$, $B_B$, $B_C$, $B_D$, $B_E$, - warehouse of co-operators;
$W_1$, …, $W_3$ – transport means;
- material flow of process $P_z$.

Fig.1. Model of production cooperating network
Source: Own work

## 3. THE METHODOLOGY OF RAPID PROTOTYPING OF LOGISTICS NETWORKS

An important element of the proposed concept of rapid prototyping production logistics networks is a transaction broker (computer system), whose task is to associate a company able to implement the order by taking into account existing constraints. The role of the broker is the selection of such companies operating in the logistics system of communication that ensure timely execution of orders at the lowest possible level ofthe total implementation cost. Schematic diagram of a broker is illustrated in Figure 2.

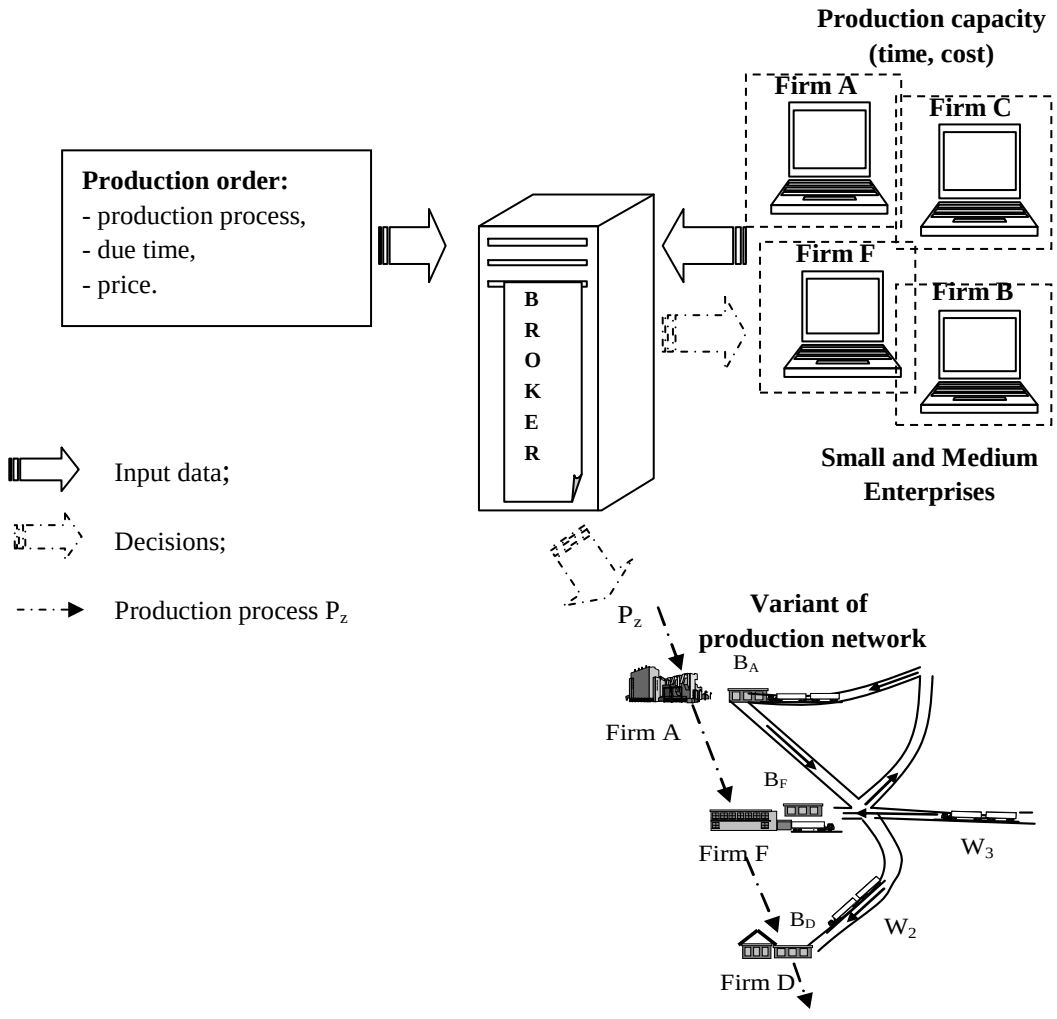



Fig. 2. The scheme of broker system
Source: Own work

The production order described by set of subprocesses including technological documentation is issued by the transaction generally accessible online transaction system. Companies make offers in this system of their available capacity, specifying the cost of using those capabilities.

Due to the high combinatorial complexity of the problem the proposed solution is based on an approach where it is being checked if the conditions are suffitient to fulfill the order implementation. Sketch of such a methodology is illustrated in Figure 3.

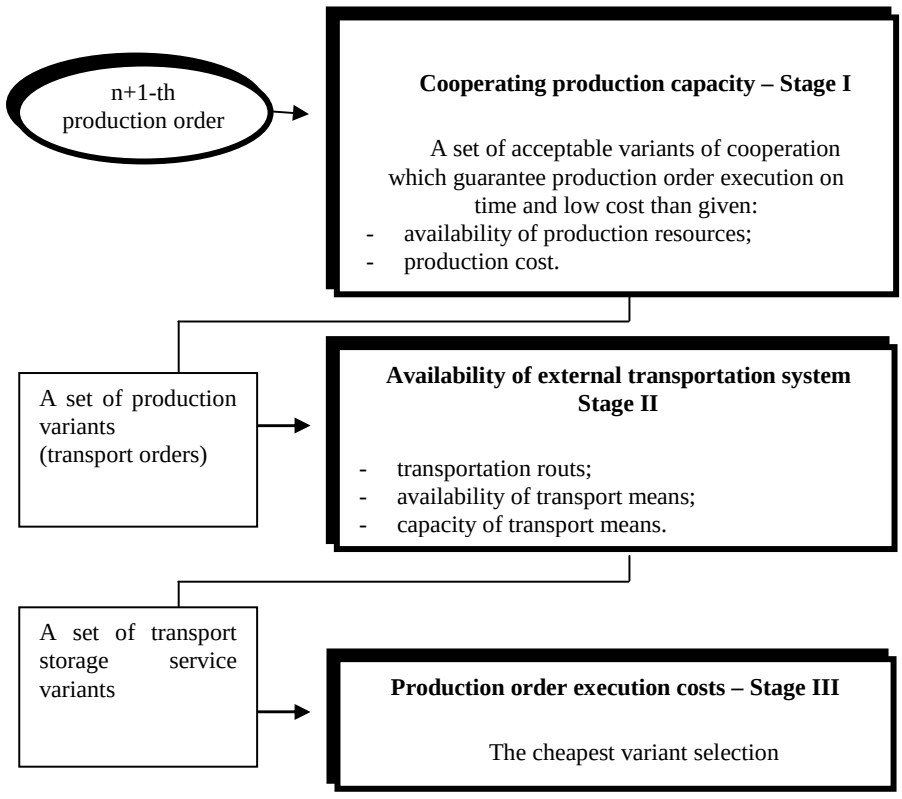



Fig. 3. The methodology of rapid prototyping production logistic networks
Source: Own work

The proposed methodology consists of three stages. In the 1st faze we look for a set of possible options that meet the production limitations as to the availability of capacity for individual companies, the consequences of the implementation of the subprocesses. At this stage the deadlines and additions to lot size (supply) based on the availability of capacity are set. In stage II a set of options is limited to those options that meet the conditions associated with the transport system. Each of the options is evaluated in terms of the structure of routes available, the quantity of available resources and capacity of transport. In the proposed approach, the transport system carries out the movement of material transactions between companies in accordance with the agreed timetable. Vehicles with known capacities, move along specific routes connecting the various participants in the logistics network. Scheduling is determined on the basis of offers of the transport companies that can ensure the availability of means of transport within a specified time interval in a given route section. This allows to quickly and reliably assess the feasibility of a new order without the need for costly (time consuming) operations re-planning of the timetable of the transport system. Application of the proposed solution guarantees the possibility to find quality feasible solutions, without disturbing the ongoing production. As a result, variants of cooperation and option for warehouse and tranportation handling are being found. This guarantees the correct execution of the order in a given period of time.

In the final stage III, the proposed methodology evaluates the total cost of the order.One way to link costs with the reasons for their formation is the account of the costs of ABC (called Activity-Based Costing). The concept of this method is based on the assumption that the indirect costs arise because the company implement specific actions used to manufacture and deliver it to the client a particular product or service. Thus, in the bill of costs there is a further step of calculation

involving the valuation of the cost of individual operations. The amount of indirect costs attributable to individual products (processes) depends on the type and amount of action needed for their manufacture [5], [7]. In this approach there are options included, which guarantee the realization of the order within the agreed price and time. Information about costs of implementation allows you to choose the cheapest variant of cooperative networks. An example of a choice of network capable to implementthe production order order is illustrated in Figure 4.

If in result we receive an empty set, the proposed methodology implies the rejection of the new order while providing information about the cause for the rejection.This allows you to make changes both in the structure of the system (an additional means of transportation, etc.) and a production order (the implementation of the negotiation period, prices, etc.).

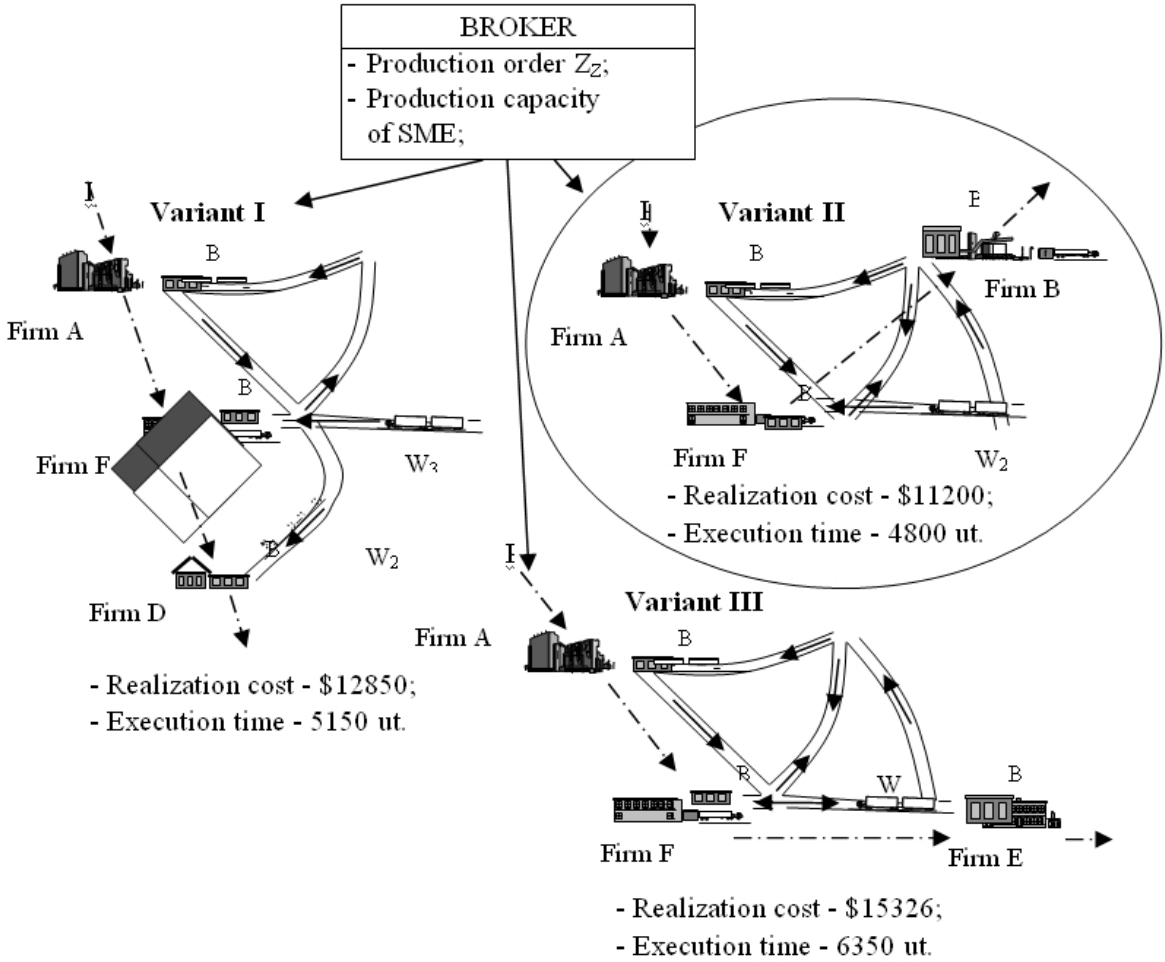



Fig. 4. Variants of production order realization $Z_Z$
Source: Own work

## CONCLUSION

The possibility of hiring a production capacity, including unused resources gives additional opportunities for co-operation of many small and medium-sized enterprises. This means that in many cases small and medium-sized companies organized under the corporate networks can compete with the much larger and stronger capital firms. Noteworthy is the lack of methods and tools for rapid (on-line) and reliable assessment of the

possibility of joint implementation of new manufacturing ventures. This raises the need to develop a methodology that allowe to explore logistics network organization and the organization of the movement of production to guarantee timely execution of orders at a given level of costs. The paper proposes a methodology based on the propagation of constraints cooperating companies, that will allow the determination of partners capable of carrying out production processes across the entire network and to assess the viability of new orders in terms of restrictions related to the transport system, storage, date, cost performance, and structure of the spare capacity of the partner. Further studies focuse on the development of standards for the description of technological and logictics operations (transport, storage) of the proposed network of potential partners and develop a computer platform for the capacity exchange. The platform (broker) will allow the rapid prototyping production logistics networks characterized by high flexibility and economic efficiency.

## BIBLIOGRAPHY

[1] Basl J., Jakubowski J., Saniuk S., *Zarządzanie procesem produkcyjnym w zintegrowanym łańcuchu dostaw w małych i średnich przedsiębiorstwach*, Inżynieria produkcji, Uniwersytet Zielonogórski, 2005.

[2] Dekker H. C.; Goor A.R.V., *Supply Chain Management and Management Accounting: A Case Study of Activity-Based Costing*, International Journal of Logistics, Volume 3, Number 1, 1 April 2000 , pp. 41-52.

[3] Kisperska-Moroń D., *Żywe łańcuchy dostaw jako przedmiot zarządzania projektem*, Prace naukowe Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław 2008.

[4] Matuszek J., *Inżynieria Produkcji*, Wydawnictwo Politechniki Łódzkiej Filii w Bielsku Białej, 2000.

[5] Ries A., *Controlling in virtuellen Netzwerken, Managementunterstutzung in dynamischen Kooperationen*, Gabler, Wiesbaden 2001.

[6] Stadtler H., *Supply chain management and advanced planning-basics, overview and challenges*, European Journal of Operational Research 163, 2005, 575-588.

[7] Saniuk A., *System szacowania kosztów w procesie negocjacji warunków realizacji zleceń produkcyjnych* w: Inżynieria produkcji: technologia, informacja, innowacja, red. J. Mutwil, J. Jakubowski, Oficyna Wydaw. Uniwersytetu Zielonogórskiego, Zielona Góra 2006, s. 145-158.

[8] Saniuk S., *Planowanie przepływu produkcji w warunkach ograniczeń logistycznych, w: Systemy wspomagania podejmowania decyzji w małych i średnich przedsiębiorstwach*, Oficyna Wydaw. Uniwersytetu Zielonogórskiego, Zielona Góra 2006, s. 129-162.

[9] Witkowski J., Zarządzanie łańcuchem dostaw. Koncepcje, procedury, doświadczenia, PWE, Warszawa, 2003.