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The flexibility and specialization of resources - competitive strategies of materials decoupling points of a network supply chain of metallurgic products

Marzena Kramarz[a], Włodzimierz Kramarz[b,*]

[a] *The Silesian University of Technology, The Faculty of Organization and Management, 41-800 Zabrze, ul. Roosevelta 26-28,*
[b] *The Silesian University of Technology, The Faculty of Organization and Management,* 41-800 Zabrze, ul. Roosevelta 26-28

Abstract

The configuration of the supply chain which realizes the postponed production strategy, requires consideration of the issue of formation of network relations in order to increase the supply potential. The increase in the number of network relations shaped by materials decoupling point of the supply chain can be a consequence of an endeavour to reduce the logistic costs, improvement in the level of the customer service or an increase in innovativeness. In the model presented in the article the authors considered the issue of reducing logistic costs with the established high level of the customer service, taking into account the problem of the flexibility of resources.

Keywords: materials decoupling points; network supply chain; flexibility resources; differentiation strategy.

1. Introduction

The cooperation of enterprises in network supply chains is an opportunity for creating innovative products and services. The structures of network supply chains tend to be various (Saniuk et al 2013). The factors which have the most essential influence on the configuration of the network supply chain is the degree of product

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: makram5@wp.pl, wkramarz@op.pl.

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differentiation, the product logistic features and market conditions, including demand fluctuations. These factors decide, among other things, about the location of the material decoupling point which is responsible for providing the continuity of flows in supply chains through proper inventory control and more generally material flows control. Organizations fulfilling the assumptions of material decoupling points, combining the supply aspect of the chain with the demand aspect, realizes different competitive strategies. One of the strategy which is strongly forced by the recipients' market and consequently affects the flows organization in the entire chain, is the product differentiation strategy to the recipient's needs. The organization which is the material decoupling point in this type of supply chains frequently takes over additional tasks connected with postponed production. For the realization of the adopted strategic objectives it uses its own resources or resources gained from its partners in the network. In the paper resources were characterized according to the attributes of flexibility and dedicatedness (specialization). As noticed by Zhang Q. et al. (2002), Baker P. (2006), the attribute of flexibility of resources becomes critical for guaranteeing the realization of the recipients' variable needs. Depending on the type of the supply chain and the type of the product, production capacities connected with flexible responsiveness to changes in demand can be located on the level of logistic centers, industrial companies or in other nodes of the supply chain.

The research presented in the paper refers to models proposed by van Mieghem J.A. and Rudi N. (2002) Jordan W.C., Graves S.C. (1995) and Graves S.C., Tomlin B. (2003) Goyal M., Netessine S. (2004). Being aware of the complexity of the issue of investment into flexible or dedicated resources one consciously limited the problem to logistic costs connected with realization of an order and with cooperation, taking into account in the model: costs of flexible and dedicated resources, transport costs connected with cooperation and product delivery, lost sale costs, costs of unused production capacities, costs of storing semi-finished goods and final goods. One strived for cost minimization with the level of logistic and customer services which was admissible and accepted by customers. The complexity and the punctuality of order realization one indicated as crucial elements of logistic and customer service in the investigated supply chain . At the same time, the authors took into account limitations connected with the production abilities of flexible and dedicated resources.

The article has the following structure. The second chapter introduces the basis of the research problem referring to the literature discussions regarding the structure of the supply chain resulting from different approaches to the realization of the postponed production strategy. In the further part, the literature research focuses on the problem of the flexibility of resources. Chapter 3 involves empirical research carried out based on the supply chain of the motor industry. In this chapter the authors shows the assumptions, introduce the research methodology and inference based on the carried out simulation experiments. Referring to the literature research concerning the postponed production strategy, the flexibility of resources and the configuration of the supply chain, the research was carried out in two stages: developing an analytical model for identification of the relationship between the variables describing nodes in the supply chain: including the degree of the flexibility of resources, the subcontracting of tasks of the postponed production, production capacities, logistic costs as well as the independent variable: demand fluctuations. The second stage was to develop a simulation model and carry out experiments. Simulation experiments were carried out in the technique of the management systems dynamics in the Vensim tool.

2. Literature review

2.1. The structure of the supply chain - the model of late differentiation of the product

The product differentiation in the supply chain, as a competitive strategy distinguishing an enterprise by the skill of adapting itself to customers' preference in respect of the selected features of the product (customizing) is one of the premises of changes in the structure of the supply chain. The product differentiation requires formation of network relations on the same level of the supply chain. Enterprises seek partners with resources allowing them to increase the value added in the supply chain thanks to the complementarity and compatibility. Cooperation in networks created on individual levels of the supply chain allows, one hand, reducing the barriers connected with the resource potential of one organization and, on the other hand, provides an opportunity to create innovative products and services. Relations shaped by central enterprises have different intensities (the interaction frequency, the stream of material and information flows), the duration and the degree of formalization (from informal relations based on mutual trust to formalized cooperation contracts) (Kramarz M. 2012). The formation of a collaboration network through material decoupling points of the supply chain is one of the competences decisive both about the efficiency of such an organization and the efficiency of material flows in the entire supply chain.

The structure of the supply chain changes depending on the model of the product differentiation: early differentiation and late differentiation. In the first variant, an industrial company manufactures a multi-variant product. So, product differentiation is realized by the producer who supplies a differentiated product to a distributional enterprise. Based on market forecasts, the distributional enterprise allocates variants of the product on different markets. In the second variant the industrial company produces the base product which is supplied to the distributional enterprise. The distributional enterprise differentiates the product (realizing tasks of the postponed production) in compliance with customers' orders. The distributor in this model fulfils the part of a material decoupling point, increasing the range of classical distributional tasks (inventory control, market investigation, transport organization, penetration of the market) for processes of the postponed production in compliance with the rule of assembly to order or production to order.

Aviv. Y., Federgruen A. (2000) define late differentiation as a strategy allowing reduction of the risk connected with offering multi-variant products by seeking a common basis for products and designing distribution products and processes so as to begin the process of their differentiation possibly at the latest.

The relationship between different classifications of the strategy was presented on fig. 1.

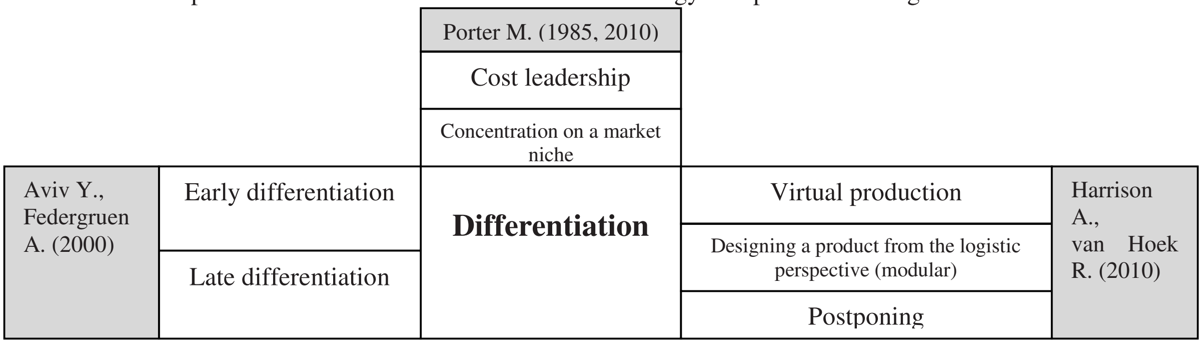

Fig. 1. Strategies of enterprises orientated to product differentiation

Source: Kramarz M., Strategie adaptacyjne przedsiębiorstw flagowych sieci dystrybucji z odroczoną produkcją. Dystrybucja wyrobów hutniczych. Wydawnictwo Politechniki Śląskiej, Gliwice 2012

While analysing the differentiation issue, Anand K. and Mendelson H. (1998) considered a model taking into account: the manufacturer of the base product, the distribution centre and two different markets to which final goods are directed, obtained through differentiation of the base product as a result of the postponed production. In the model they analysed two configurations of such a supply chain: earlier and later differentiation. Continuing these investigations, Anand K. and Girotra K. (2007) considered late differentiation as a variant whose choice is influenced by the strategic behaviour of the competition. Every enterprise in the model developed by Anand K. and Girotra K. also chooses between two different configurations of the supply chain: early and late differentiation, but with relation to the earlier model the decision model includes an additional factor influencing the choice of the strategic option - the competitor's decision as regards configuration of the supply chain. Early differentiation involves reaping profits from the time of reaction to the customer's needs (the strategic pool which depends only on the size of the market in which both enterprises compete), however late differentiation reaps profits from the risk pool.

The authors showed that for a slight differentiation of demand parameters both enterprises prefer earlier differentiation rather than later differentiation. It must be stressed that in the model the authors took into account two key parameters. The first of them, the risk pool bonus, favours late differentiation and is increasing with the growth of the competition on the market (it is a function of the variance of demand and the coefficient of correlation between markets). The second component investigated by the authors in the competitive system is the strategic bonus, which is a function only of the size of the market in which two enterprises compete and is higher for earlier differentiation. The variability of customers' needs, in compliance with the mentioned models analysed in the literature, is treated in the research presented herein as the key parameter decisive not only about the decoupling point of the supply chain (including about early or late differentiation) but also about the selection of partners in the distribution network and also the types of formed relation.

Similarly in the context of strategic choices in the area of flexible production systems, the differentiation strategy is considered by Goyal M. and Netessine S. (2007). The authors consider the problem in three stages: the choice of flexible or dedicated production technology (the technological game), the decision concerning production capacities, and the decision concerning the production quantity in a given period of time (the production game). The two first decisions are undertaken ex ante, before appointing the curve of needs, the last decision is undertaken ex post based on the available information about the needs and their uncertainties. In the strategic decisions the authors consider four effects: the market size effect, the product substitutionality effect, the stochastic effect and the cost effect. Just like in the research presented earlier, the authors stress the advantages of the flexibility obtained thanks to late differentiation in providing for the insecure needs for multi-variant products. The "risk pool profits" analysed by Anand K. and Girotra K. are analogous to the stochastic effects discussed by Goyal M. and Netessine S. (2007), and the "strategic profits" to the market size effects. The authors prove that as a result of aggressive activity of the competition the value obtained thanks to late differentiation can be limited. This makes early differentiation more valuable, which entails strategic profits. The most essential conclusion from the carried out research was the statement that early differentiation entails strategic profits, yet in the later differentiation variant the strategic profits are limited but there appear profits connected with the risk pool.

Taking into account in the research the findings obtained by Anand K., Girota K., and Goyal and Netessine (2007), the authors focused on the configuration of the supply chain including the aspect of the subcontracting of tasks of the postponed production in the issue raised by the mentioned researchers. So, taking into account high demand fluctuations and the strategy of the differentiation of the product, attention was focused on supply chains with the network structure designed according to the pattern of late differentiation. It was assumed that the formation of network relations by the distributional enterprise realizing postponed production tasks is connected mainly with searching for partners possessing rare resources, compatible with the resources of the material decoupling point. The resources used in the postponed production process were described with the attribute of the degree of the resource flexibility.

2.2. Flexibility as a resource attribute

The best functioning supply chains are characterized with three features: the flexibility (they quickly react to sudden changes in demand or supply), the adaptivity (they adapt themselves to market changes by evolving structures and adaptive marketing strategies) and take into account the interests of all the enterprises in the network (acting in the name of their own interests, simultaneously improving the functioning of the entire supply chain). The strategy supporting the operational flexibility is the postponed production strategy, yet adaptation to changes in the environment is supported by shaped relations in networks and supply chains which allow catching market opportunities and reconfiguration of marketing strategies.

As noticed by Zhang Q. et al. (2003), Baker P. (2006), the attribute of the flexibility of resources becomes critical for providing for the realization of variable recipients' needs. Depending on the type of the supply chain and the type of the product, the abilities connected with flexible responsiveness to changes in demand can be located on the level of distribution centres, production companies or in other nodes of the supply chain.

The term "flexible resources" in the definition by Sethi A.K. and Sethi S.P. (1990) refers to resources with the capability of producing many variants of products. The flexibility of resources in the distribution network with postponed production is related to the investigation into the production flexibility, which requires a hierarchical analysis for different strategic business levels until the level of individual machines. These resources require space, IT systems, workers enabling integration and co-ordination of these resources during the process. In the case of machines connected with postponed production, one ought to additionally consider the availability of storage capacities for the needs of realization of new tasks.

Numerous research models of decision-making issues concerning investments in a resource and expressing the problem of its flexibility (including: Van Mieghem J.A. and Rudi N. (2002))are built as a two-stage issue of the stochastic programming. On the first stage (the planning stage), the resource investment decision is created on the basis on uncertain needs, however, on the second stage (the production stage) the uncertainty is limited and resources are allocated to the required production. Similar investigations were carried out by: Jordan W.C., Graves S.C. (1995) and Graves S.C., Tomlin B. (2000) for multiproduct multi-institutional processing systems , Goyal M., Netessine S. (2004) concerning the inclusion of the competition into aspects of decision-making, and van Mieghem J.A. (2004) concerning the inclusion of reluctance to take risk in investment decisions. ON the basis of these investigations i can be inferred that flexible and dedicated resources can be perceived as financial variants of investment decisions while taking into consideration the uncertainty of the future utilization of the production capacity of these resources. Several researchers stress that by investing into flexible resources enterprises can enlarge their own market position, tailoring the realized tasks to variable needs of the market and the supply chain better than enterprises investing into dedicated resources.

The research presented in the literature shows that the more competitive the market is, the more visible is investing into flexible resources. It can be justified by the fact that enterprises must then constantly modify their product, which is difficult with dedicated resources. On the other hand, a strong competitive struggle in the sector does not favour gaining resources through coopetition, so the enterprises must build their flexibility through own resources.

Similarly to the research by Mitsuhashi H., Greve H. (2009), the effects affecting the investment decision are considered by Goyal M., Netessine S. (2007). The authors also include into their analysis the competition and its influence on the undertaken decisions as regards the flexibility scale.

First they consider investments into flexible and dedicated production capacities with lack of competition and analyse trade-off relations between heavy expenses of flexible resources and their ability to the provide for contradictory uncertain needs via production of differentiated products. In the second step, including the competition into in the decision-making process, they consider a situation in which each of the enterprises can invest into two dedicated technological lines or one flexible one when decisions are undertaken independently. Each of the enterprises manufactures both products and competes with the other enterprise on both markets. Each enterprise undertakes three sequential decisions. The first is to choose a production technique (the technological game) as dedicated (D) or flexible (F). The second is to invest into production capacities of a given resource (the production capacity game). These two decisions are undertaken ex ante before the curve of needs is exactly recognized due to a long period of time accompanying the acquirement of certain resources. The final decision which is determined by two earlier decisions, concentrates on the production level of every product. The flexibility in the paper by Goyal M., Netessine S., is treated first of all as a possibility to satisfy higher needs on the market of one product based on the production capacity reserved for another product on which the demand in a given period of time is lower. For dual considerations the same problem becomes complicated when both competitive enterprises should come to a decision about high technological flexibility. Both enterprises will be then identically able to realize increasing future needs of one of products, which will lower their individual attractiveness.

Referring to the stochastic effect, every enterprise is inclined to increase its investment into flexible production capacities according to the growth of the uncertainty of needs. When the uncertainty of needs is low, enterprises will undertake decisions about investments into dedicated resources which are cheaper. If one product market is bigger than another, then production capacities of the flexible resource will be directed to this market. This statement provides the basis for explanation of the market effect. High substitutionality of needs (the product substitutionality effect) strengthens both the stochastic and market effect. The cost effect presents an asymmetry in an inclination to increase higher costs connected with flexibility when both enterprises invest into the flexible technology.

In the study presented in the paper, the authors changed the assumption concerning the purely competitive attitude of two enterprises. It was assumed that enterprises undertake cooperation, consequently it becomes essential to set the flexibility degree of the resource possessed by the base the basis enterprise (materials decoupling point) and the range of functions realized on the basisi of the subcontractor (taking into account resources of the partner in the network).

Simultaneously the authors took into account relations indicated by Goyal M., Netessine S. (2007) as well as Mitsuhashi H., Greve H. (2009) between costs of flexible and dedicated resources as well as the influence of the uncertainty of demand on investment decisions. Additionally, it was necessary to take into account logistic costs connected with cooperation (including costs of stockpiling and the transport cycle between the material decoupling point and the subcontractor).

From the perspective of the issues of distribution with the postponed production, the spatial analysis of the network and the resources which were selected for further analysis and research (warehouses together with their additional infrastructure allowing adaptation of the product to the customer's needs), the attribute of the resource flexibility was acknowledged as highly essential. The production infrastructure in such a node as the material decoupling point realizing tasks of the postponed production, can be flexible allowing realization of orders of different segments of recipients, or can be dedicated to a particular segment. Simultaneously, other nodes based on partnership can specialize in realization of substitutional or complementary tasks in relation to this central chain link of the network. In the research presented in Chapter 3 the resource flexibility was determined in compliance with the assessment of the realization by the resource of operations allowing adaptation of the base product to the needs of different segments of recipients. Therefore, the flexibility degree of the resource depends on the number of segments to whose needs a given resource is in a position to adapt the product and also labour intensity generated by individual variants of products. At the same time, this is a dimension of a possible degree of product differentiation.

3. The simulation of strategic decisions of the material decoupling point in a supply chain of steel tubes

Modelling of resource decisions in regard to the research problem was carried out according to two main stages:

Stage 1 - developing an analytical model. This stage of research allowed obtaining relations between the investigated variables and distribution of costs, demand and load of machines and data as regards the cycle of realization of an order

Stage 2 - developing a simulation model based on relations obtained as a result of the realization of Stage 1, and carrying out simulation experiments.

The first stage was realized in a selected material decoupling point of the supply chain of metallurgic products. In the metallurgic industry, the location of the material decoupling point is connected with the realization of the postponed production strategy, which is the responsibility of service centres and steel yards. Individual segments of recipients place requests for different variants of the product. Therefore, distributional enterprises must come to a decision about the degree of the flexibility of a resource and about a potential option of commissioning the remaining operations on the basis of subcontracting to partners in the network.

The research concentrated on a selected product: steel tubes and on activities connected with cutting and chamfering tubes.

The decision variants took into account four types of machine.

- Machines for simultaneous cutting and chamfering tubes (These machines are intended for simultaneous cutting and chamfering tubes in a wide range of diameters and thicknesses of sides as well as material from which the tubes are made. This is the highest flexibility degree of a machine allowing maximum differentiation of the product, the flexibility degree = 4)
- Machines for chamfering tubes. Chamfering machines allow preparation of different types tubes for welding. The machines perform following operations: chamfering, planning, rolling up. The flexibility degree of this machine is average and was determined on the level of 3.
- Machines for planning tubes. These machines are mainly intended for planning tubes with thin sides (stainless steel). One can also plan, chamfer and roll up tubes made of carbon steel. The toolholder enables fastening simultaneously 4 cutting tools, which allows making a very complicated form of the end of the tube by a single processing. The flexibility degree of this machine is average and was determined on the level of 2.
- Highly efficient machines for chamfering tubes. They are intended for working with large production loads. Thanks to the use of carbide tools the processing time was shortened to the minimum. This is a dedicated machine with the lowest flexibility degree and the shortest time of operation realization, the flexibility degree =1)

The diagnosis of the logistic system (Kiba – Janiak M, Witkowski J., 2012) is the first step forming the basis for assessment of the complexity of the decision-making issue as well as indicating the key criterion of the assessment of the proposed solutions. The base enterprise (material decoupling point) realizes orders from key recipients of 4 different industries. Each industry places an order for a different variant of the product. The recipients indicated the following as crucial elements of the logistic customer service: completeness and punctuality. Therefore, the model took into account the parameter of orders completed in the time limit appointed according to the contract in relation to all the placed orders. The lost sale concerns unrealized orders in compliance with the customers' expectations. The cost of the lost sale was estimated according to the individual markup of the product. Moreover, the results of the measurement of processes realized in the material decoupling point and the analyses of the branch statistic data allows adopting the following assumptions taken into account afterwards in the simulation model:

- The growth of the flexibility of the machine is accompanied by an increase in the realization time of an operation and also the cost connected with its acquirement.
- The reduction of the flexibility degree of the machine entails the development of cooperative relations instead of a resignation from a number of orders.
- The presented findings of experiments concern an average fluctuations of demand within up to 50%.
- The resource production plan takes into account a daily machine load involving the accumulative production plan of manufacturing different variants of the product.

The model, which by design simplifies the decision-making issue to criteria analysed by the researchers, took into account logistic costs connected with transporting the products from the co-operator to the finished goods warehouse of the material decoupling point, the storage costs of the final goods in the material decoupling point and also the costs of the resource stoppage in the material decoupling point.

Stage 2 was realized using the tool for building a simulation model in the technology of the management systems dynamics - VENSIM DSS. According to the logic of the management systems dynamics, elements of a complex system, which is the system composed of cooperating organizations in a network, form relations which, as a result of feedbacks and the complexity of the relations, result in strengthening or weakening the results of events disturbing the activity of the system.

The use of system dynamics allows indicating the variability of the investigated parameters depending on fluctuations of demand accompanied by indicating the loop of feedbacks. The applied simulation tool: Vensim is a software for simulation enabling improvement of the parameters of the real systems set by the researcher.

Vensim DSS is a product allowing creation of simulators for complex systems with a large differentiation of interaction between the elements and inclusion of large number of variables. The equation editor helps to build equations for the simulation model. This tool also enabled using patterns of continuous and discreet delays and, especially essential in the carried out research, taking into account smoothing of fluctuations of demand, by indicating the fact of reaching the equilibrium by the system through steering variables determined by the researchers.

Figure 2 presents a simulation model of strategic decisions of the material decoupling point as regards the resource flexibility degree.

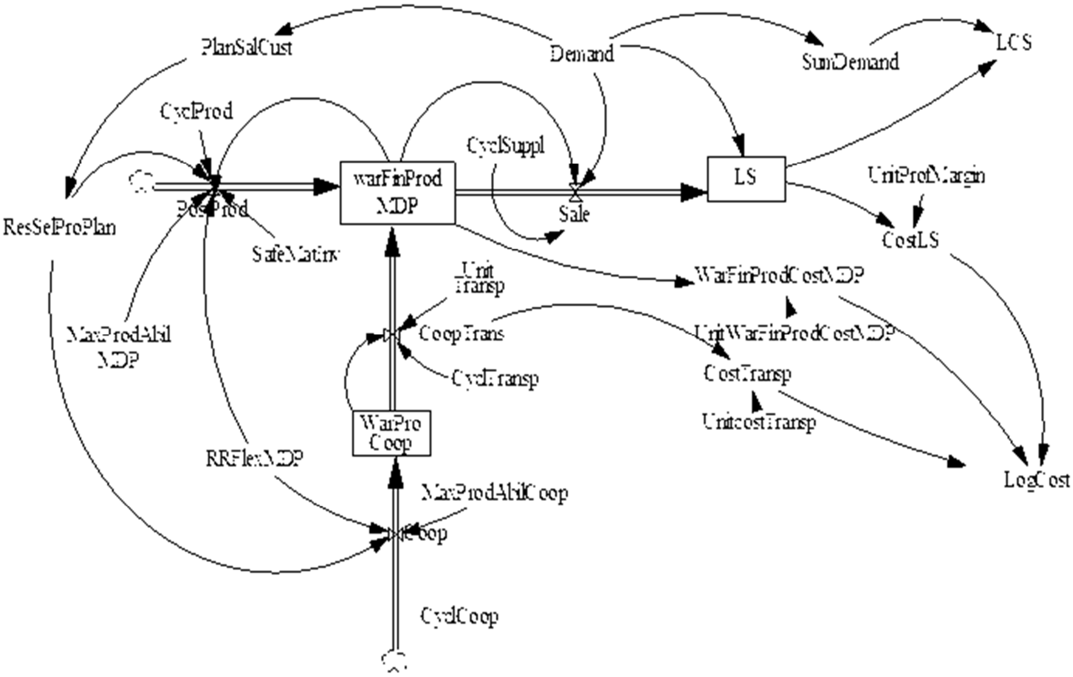

Fig. 2. The model of resource flexibility of the material decoupling of point

Where:

Material decoupling point – MDP, Warehouse of finished products of the material decoupling point – WarFinProdMDP Lost sale – LS, Warehouse of finished products at cooperator's – WarProdCoop, Logistic customer service – LCS, Summary demand – sumDemand, Cycle of supplies – cyclSuppl, Postponed production – PostProd, Planned Sales of customers – PlanSalesCust, Production cycle – cyclProd, Resource Selected Production Plan – ResSelProdPlan, Maximum production ability of the meterial decoupling point = MaxProdAbilMDP, Safe Material Inventory - SafeMaterialInventory, Transport cycle – transpCycle, Transport Unit - TranspUnit, Cooperative transport – CoopTransp, Rate of resource flexibility of the meterial decoupling point - RRFlexMDP (Rate of resource flexibility), Maximum production ability of the cooperator – MaxProdAlilityCoop, Cooperator's cycle – CoopCycle, Logistic cost – LogCost, Costs of the warehouse of finished products – WarFinProdCostMDP, Individual costs of the warehouse of finished products – UnitWarFinProdCost, Transport cost - TranspCost, Unit transport cost – UnitCostTransp, Lost sale cost – LostSaleCost, Unit profit margin of the product - UnitProfMargin

The model was described by means of equations obtained as a result of the statistical analysis.

Coop = MIN (ResSelProPlan * (1-RRFlexMDP), MaxProdAbilCoop),

CoopTrans = IF THEN ELSE (WarProCoop /CyclTransp> UnitTransp /CyclTransp, UnitTransp /CyclTransp , 0)

CostLS = UnitProfMargin * LS, CostTransp = CAŁKOW (CoopTrans * UnitcostTransp, 0), CyclCoop = 1 (week), CyclProd = 3 (week), CyclSuppl =1(week) CyclTransp =1 (week), Demand =RANDOM UNIFORM (40, 100, 50)(piece/week), Period of Time = 100 (weeks), LCS =(SumDemand-LS) / SumDemand

LogCost = CostLS + WarFinProdCostMDP + CostTransp, PostProd = IF THEN ELSE (warFinProdMDP / CyclProd <ResSelProPlan * RRFlexMDP + SafeMatInv / CyclProd , MIN (ResSelProPlan * RRFlexMDP + SafeMatInv / CyclProd, MaxProdAbilMDP), 0), Sale = IF THEN ELSE (Demand <warFinProdMDP / CyclSuppl, Popyt, warFinProdMDP / CyclSuppl)

Simulation experiments aimed at indicating the decision-making variant concerning the flexibility degree of the resource which is the most rational in respect of the rate of the logistic customer service and the logistic cost with demand fluctuations up to 50%.

The rational choice of the flexibility degree of the resource assumed that with a high level of the rate of the logistic customer service (more than 0.95), the key criterion determining the choice of the variant is logistic cost. The researchers made an attempt to choose the decision-making variant ensuring the lowest costs and reducing the level of unrealized orders.

Two decision-making variants were analysed. The first variant referred to purchasing by the materials decoupling point the distribution a resource on the highest flexibility degree (flexibility = 4, a machine for simultaneous cutting and chamfering tubes). The flexibility of this resource enables realization of all orders in the material decoupling point. In the second variant it was assumed that the materials decoupling point completes 70% of the placed orders and it commissions 30% of the placed orders to the subcontractor who has at his disposal a dedicated resource (strong specialization, flexibility on level 1, machine 4). In this variant the material decoupling point possesses machine 2 or 3, allowing realization of orders of some segments. The materials decoupling point creates network cooperation with a cooperator possessing a dedicated resource. This cooperation is based on a cooperation contract which defines the availability of cooperator's resources for the needs of tasks commissioned by the material decoupling point. The authors did not investigate the variant in which the material decoupling point has a strongly dedicated resource at his disposal.

The carried out experiments showed that together with the growth of fluctuations of demand, maintaining a high efficiency (the rate of logistic customer service more than 0.95), the logistic cost of variant 1 are on the increase. It is connected with a prolonged cycle of realization of an order and with resources protecting each variant of the product, which results in keeping the sale continuity. Fluctuations of demand exceeding 30% with maintaining the high level of customer service show lower logistic cost for variant 2 including the cooperator possessing a dedicated resource at his disposal.

The carried out experiments did not take into account the effect of sizes of market for each variant of the product.

As noticed by Zhang Q. et al. (2002), Baker P. (2006), the attribute of resource flexibility becomes critical for ensuring the realization of variable recipients' needs. The research presented in the literature shows that the more competitive market the more additional investment into flexible resources. It can be justified by the fact that enterprises must then constantly modify, change the product, which is difficult in dedicated resources. On the other hand, a strong competitive struggle in the sector does not favour gaining resources via coopetition, so enterprises must build flexibility through their own resources.

4. Conclusions

Organizations fulfilling the assumptions of material decoupling points, combining the resource part of the chain with the demand part, realizes different competitive strategies. One of the strategies which is strongly forced by the recipients' market, consequently affecting the organization of flows in the entire chain, is the strategy of product differentiation to the recipient's needs.

The best working supply chains are characterized with three features: flexibility (they react quickly to sudden changes in demand or supply), adaptivity (they adapt themselves to market changes by evolving structures and adaptive market strategies) and take into account the interests of all the enterprises in the network (acting in the name of their interests, simultaneously improving the functioning of the entire supply chain). The strategy which supports operational flexibility is the postponed production strategy yet the process of adaptation to changes of the environment is supported by the relations formed within the networks and the supply chains which allow catching market bargains and reconfiguring market strategies.

Considerable demand fluctuations within the range over 30% cause that the material decoupling points want to keep a high level of efficiency measured with elements of the logistic customer service, essential from the customer's point of view, should invest into average-flexible machines, which allow satisfaction of the most typical recipient's needs, yet they should commission other tasks to their partners in the network. This variant ensures lower logistic costs. Therefore, the increase in demand is accompanied by the growth of the complexity of the distribution network built for the needs of complex realization of logistic tasks and connected with the postponed production.

References

Anand K., & Mendelson H. (1998). Postponement and information in a supply chain. Working paper. Graduate School of Business, Stanford University, CA 1998.

Anand, K. S., & Girotra. K. (2007). The strategic perils of delayed differentiation, *Management Science,* 53 (5), 697-712.

Aviv. Y., & Federgruen A. (2000). Capacitated Multi-item Inventory with Random and Seasonal Demand: Implications for Postponement Strategies., *Management Science*, 47, p. 512-531.

Aviv Y., & Federgruen A. (2001). Design for postponement: A comprehensive characterization of its benefits under unknown distribution., *Operations Research,* 49, p. 578-598.

Baker P. (2006). Designing distribution centers for agile supply chains. *International Journal of Logistics: Research and Applications*, 9(3), p. 207-221.

Jordan W.C., & Graves S.C. (1995). Principles on the benefits of manufacturing process flexibility. *Management Sci*ence, 41(4), p. 577-594.

Goyal M., & Netessine S. (2007). Strategic technology choice and capacity investment under demand uncertainty, *Management Sci*ence, 53(2), p. 192-207.

Graves S.C., & Tomlin B. (2003). Process flexibility in supply chains. *Management Science*, 49(7), p. 907-919.

Kramarz M. (2012). Strategie adaptacyjne przedsiębiorstw flagowych sieci dystrybucji z odroczoną produkcją. Dystrybucja wyrobów hutniczych. Wydawnictwo Politechniki Śląskiej, Gliwice.

Mitsuhashi H., & Greve H. (2009). A matching theory of alliance formation and organizational success: complementarity and compability. Academy of Management Journal, 52(5).

Saniuk A., Witkowski K., & Saniuk S. (2013). Management of production orders in metalworking production, 22nd International Conference on Metallurgy and Materials - METAL 2013, TANGER, Czech Republic, Brno 2013, p. [6] CD-ROM.

Sethi A.K., & Sethi S.P (1990). Flexibility in manufacturing: A survey. *International Journal of Flexible Manufacturing Systems* 2, p. 289-328.

van Mieghem J.A., & Rudi N. (2002). Newsvendor networks: Inventory management and capacity Investment with discretionary activities. *Manufacturing & Service Operations Management*, 4(4).

Witkowski J., & Kiba – Janiak M. (2012). Correlation between city logistics and quality of life as an assumption for referential model, *Procedia - Social and Behavioral Sciences,* 39 p. 568-581.

Zhang Q., Vonderembse M.A. Lim J.S. (2003). Manufacturing flexibility: Defining and analyzing relationships among competence, capability, and customer satisfaction. *Journal of Operations Management* 21, p. 173-191.