CONFIGURATION OF PRODUCTION ENTERPRISES SUPPLY CHAINS BY THE CUSTOMER

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Abstract

Companies that are in the supply chain of a product are usually quite conservative in their changes, and supply chains are stable and unchangeable because all participants in the chain are partners. On the one hand, this is a positive characteristic of chains, on the other hand, it prevents formation of such a property of chains as flexibility in relation to products` customers. Customers determine demand characteristics, but they depend on both external and internal factors. This circumstance forces supply chains to look for the ways of implementing the flexibility characteristics in relation to customers.

In this paper, a concept for developing supply chain flexibility is considered. A mechanism for its implementation was tested when configuring supply chains with the customers` participation. It is estimated that this will allow us to solve the issues of manufacturing orders within the framework of the main requirements of customers in terms of price, speed and quality in an order follow-up due to the fact that a customer directly affects formation of the supply chain in the process of order.

Key words: supply chains, flexibility, order, customer, individualized products, demand, production enterprise.

1. INTRODUCTION

Necessity to focus logistics on individual customer requests is noted by many researchers, in particular (Waters, 2003), (Stock, 2005), (Johnson, 2002) and others. At the same time, it is revealed that in case of production strategies` adaptation to the individual requirements of a customer, the transformation of supply chains occurs,

and they become individualized. McKinsey experts believe that "development of specialized products will provide optimal value for the customer and help to minimize costs and inventory in the supply chain" (McKinsey&Company, 2016).

This paper examines the possibility of developing such a specialized product that allows configuring the supply chains of individualized products, that is industrially manufactured serial products, but taking into account consumers` individual requirements for each specific order.

Conceptual requirements for supply chains of individualized products that reflect their features are the following:

- improving efficiency of material flows through supply chains by reducing length of production cycles of enterprises participating in supply chains;
- optimizing inventory levels and reduce delivery terms in conditions of distributed assembly of customized products;
- increasing the level of customer satisfaction by increasing the flexibility of supply chains and rapid response to changing customer requirements by attracting customers to the initial stage of creating supply chains of customized products;
- achieving the realized goals of supply chains through cooperation between chain participants by developing integration technologies for inter-organizational coordination in the supply chains of individualized products.

Conceptual requirements for supply chains of individualized products allow us to identify their specific features:

- customized product supply chains are flexible, allowing one to change components` suppliers quickly to meet customer`s needs, creating different combinations and configurations of supply chain participants for each order;
- the material flow in the supply chains of individualized products on the way from the source of raw materials to the final consumer passes through the supply chain, in the production links of which the conversion of components and assembly modules into finished individualized products takes place;
- the main task of logistics in the supply chains of individualized products in the conditions of distributed assembly is to provide manufacturing enterprises with components and assembly modules of the necessary quantity and quality within the deadlines set by orders and customers;
- the flexibility of enterprises` logistics systems in the supply chains of individualized products is provided by availability of universal equipment and service personnel at production enterprises, which allows them to dynamically reconfigure to produce other products, increase production capacity or reduce production volume.

The study compares the processes in supply chains in the production of standardized, mass-produced products with the processes in the supply chains of individualized products. It follows from the analysis that the specifics of supply chains for individualized products differs from supply chains for mass production and from production to order. Products of individualized production are produced in small batches, the final version of the product is agreed with the customer before moving through the supply chain, which is perceived by the consumer as a unique service. In the supply chains of individualized products, there are almost no warehouse stocks of

finished products, stocks of work-in-progress, and the volume of raw materials and materials is minimal to ensure operational work. Consequently, there is a significant reduction in warehouse costs and inventory. Enterprises of individualized products apply "just in time" principle.

However, individualization of supply chains also has disadvantages: getting information from customers is difficult; logistics and distribution of real products to real consumers in real time and with a regulated real price is complicated; the production process must be flexible, which leads to an increase in material and production costs. The types of functional problems, sources and causes of problems in the supply chains of individualized products are studied on the example of the individualized market of translucent structures in the Krasnoyarsk territory. Based on the results of the study, options for measures to solve the identified problems are proposed.

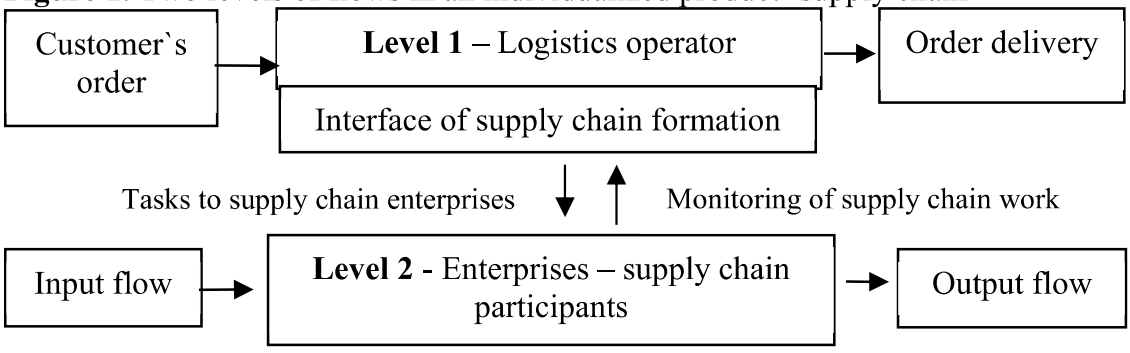
It is determined that a way to solve existing problems in the supply chains of individualized products is integrative. At the same time, if we apply existing logistics methods for supply chains of individualized products, it causes characteristic management problems associated with the lack of methodological tools for logistics to solve problems of managing supply chains of individualized products in a distributed assembly.

The identified problems and their causes, however, do not prevent the increasing role of individualized production in the regional economy. This is due to the fact that individualized production is mainly engaged in small and medium-sized businesses, which is associated with a fairly low "entry threshold" in the market due to the low cost of equipment, and due to the specific need to quickly respond to individualized orders of end customers, which large enterprises are unable to respond quickly.

2. ANALYSIS OF THE INDIVIDUALIZED PRODUCTS` REGIONAL MARKET

Actually, it is possible to differentiate all participants in two levels of an individualized supply chain: the first level combines material flows, the second level – information, i.e. management flows (Fig. 1).

Figure 1. Two levels of flows in an individualized product` supply chain



Source: Lukinykh, 2010

Introduction of a management level is caused by the fact that deviations from standard conditions requested by a customer regularly occur, which brings elements of stochasticity to the flow of individualized production. Therefore, in connection with the need to implement the principles of flexibility and dynamism of supply chains of individualized products and reduce risks for non-standard types or unpredictability of orders, it is proposed to introduce a management link called "Logistics operator". The logistics operator is a link in the supply chain of manufacturing enterprises and it performs the function of inter-organizational coordination in the supply chains of individualized products in accordance with the content of end customers` orders – consumers.

The problem of inter-organizational coordination is proposed to be solved by taking into account that the process of optimal formation of individualized products` supply chains has two main directions: optimization of supply chain elements and ensuring effective interaction between the supply chain links. The following principles are taken into account: consistency, hierarchy, integrity, formality, structure and variability.

In the research process features of the strategic positioning of firms in channels of distribution and features of enterprises` aggregation in supply chains on the example of Krasnoyarsk region are identified. For this purpose, the analysis of enterprises producing plastic windows was carried out (Tab.1).

Table 1. Analysis of the enterprises producing plastic windows in the Krasnoyarsk region

Enterprise	Volume pcs/ mnth	Price segment	Profile quantity pcs	Furniture quantity, pcs	Geography	Chanel distribution participants	Service level (by experts)
1	2	3	4	5	6	7	8
"Avangard"	500	Middle Economy+	4	2	Krasnoyarsk, Krasnoyarsk region	Dealers, builders, private individual	Low
"Alter"	200	Economy	2	2	Krasnoyarsk, Sosnovoborsk	Builders	Low
"Artiks"	500	Premium, Middle	4	2	Krasnoyarsk, Krasnoyarsk region	Dealers, builders, private individual	High
"Artservice"	100	Economy	4	2	Krasnoyarsk	Private individual	Low
"Arttech"	500	Premium, Economy+	4	3	Krasnoyarsk, Krasnoyarsk region	Dealers, builders, private individual	High

“Bavarskiye okna”	500	Middle Economy+	3	1	Krasnoyarsk	Private individual, dealers	High
“Bimax”	700	Premium, Economy	4	2	Krasnoyarsk, Krasnoyarsk region	Dealers, builders	Middle
1	2	3	4	5	6	7	8
«BFK-Yenisey”	4500	Premium, Middle	4	1	Krasnoyarsk region	Dealers, builders	High
“Vitrazh”	500	Middle, Economy	4	1	Achinsk, Krasnoyarsk region	Dealers, builders	Middle
“Vlanta”	100	Economy	2	1	Krasnoyarsk	Private individual	Low
“Zodchy”	200	Economy	2	2	Sharypovo, Krasnoyarsk region	Private individual, builders	Middle
“Introkna”	300	Middle	1	2	Krasnoyarsk	Builders	Low
“Comfort+”	200	Middle	2	2	Zelenogorsk, Krasnoyarsk region	Private individual, builders	Middle
“KrasAl”	500	Premium, Economy	3	2	Krasnoyarsk, Krasnoyarsk region	Dealers, builders	Middle
“KrasZapadSibStroy”	200	Middle	1	1	Krasnoyarsk	Builders	Low
“YarDecor”	100	Middle	4	2	Krasnoyarsk, Krasnoyarsk region	Dealers, builders	Middle
“Module”	100	Middle	4	2	Krasnoyarsk	Private individual, builders	Middle
MSK	200	Economy	1	2	Krasnoyarsk	Builders	Low
SPK	400	Economy +	1	1	Krasnoyarsk	Builders	Middle
“Okna BNV”	1000	Middle, Economy	3	1	Krasnoyarsk, Krasnoyarsk region	Dealers, builders, private individual	High
“Okno”	500	Middle. Economy	3	2	Krasnoyarsk, Krasnoyarsk region	Dealers, builders, private	Middle

						individual	
“Plastica”	1000	Economy, Economy+	4	2	Krasnoyarsk, Krasnoyarsk region	Dealers, private individual	Middle
“Plastic-off”	200	Premium, Economy	3	2	Krasnoyarsk	Dealers, private individual	Middle
1	2	3	4	5	6	7	8
“M32”	100	Middle	1	1	Krasnoyarsk region	Builders	Middle
“SibAlPlast”	100	Economy	1	1	Krasnoyarsk	Private individual	Low
SLM	1500	Economy	1	1	Krasnoyarsk	Builders	Middle
“Sovremenny e okna”	5000	Premium, Middle Economy Economy+	8	3	Krasnoyarsk, Abakan, Krasnoyarsk region	Dealers, builders, private individual	High
“Formica”	100	Middle	2	1	Krasnoyarsk region	Builders, private individual	Middle
“Fenestra”	500	Middle	1	1	Krasnoyarsk	Builders	Middle
“Yakubchak”	200	Middle	2	2	Krasnoyarsk region	Dealers, private individual	Middle
Others	4500						
Total	25000						

Source: authors` development

Analysis of the data shown in table 1 allowed us to formulate the following conclusions:

1. Large number of window manufacturers in the Krasnoyarsk region leads to a significant level of competition in the market.
2. Firms are represented in all price segments: the majority in the “Economy” segment (35%) and “Economy+” (30%), a large number in the middle price segment (25%) and a small number in the “Premium” segment (10%).
3. Large firms operate in all distribution channels; all price segments and they are widely represented geographically. Small firms specialize in local markets and a narrow group of customers.
4. Market leaders are characterized by a high level of service, which allows one to apply a premium for quality and service. Companies that specialize in the construction market offer the level of service required for this particular target audience. In fact, each market segment has its own specific requirements for products and service levels.

Based on the characteristics considered, window enterprises in Krasnoyarsk are grouped into strategic groups by the number of distribution channels in the supply chain and the occupied market segment.

There are about fifty manufacturing enterprises engaged in production of individualized products - plastic windows- in the regional market of the Krasnoyarsk region. All production enterprises were divided into groups, depending on the production capacity and distribution channels of finished products:

Group 1 includes large regional firms (4000-5000 products per month) that have an extensive dealer network, a developed retail sales network, and work with builders. They have a large number of personnel (more than 100 people); productive equipment (100-200 products per shift); large production areas of 4000-5000 m2; well-developed sales department (dealer department, private clients` department, corporate department); large staff of installers; marketing department. They are present in every market segment and in all price groups. They have a supply department, partner programs with suppliers, and discounts for purchasing large quantities of components. The service level is high.

Group 2 - average regional firms (500-1500 products per month), that have a dealer network in the region, sales offices in Krasnoyarsk, do not have sales offices in other cities of the region, participate in construction projects. The number of personnel is from 20 to 100 people; equipment with a capacity of 20 to 100 products per shift. Production shop is 1000-2000 m2. Larger companies have a dealer department, but the bulk of them do not, and the sales office performs universal functions. There is usually no marketing department. Market presence is in some price segments, in most sales channels. Not every company has a supply department, and there are usually partner programs with suppliers. They also have discounts from suppliers for purchases of large quantities of goods. The service level is high, sometimes medium (depending on the sales channel).

Group 3 includes small firms (100 - 400 products per month), specializing in one of the market segments, sometimes go to other segments. Production equipment is 20-40 products per shift; production shop is 200 - 500 m2. There is no marketing department or dealer department. The head of the company with the office staff performs all functions. There is usually one, sometimes two, distribution channels. There is no supply department as well. Partner programs are minimal, at the level of advertising support. Large quantities are rarely purchased, and discounts are minimal. The service level is average.

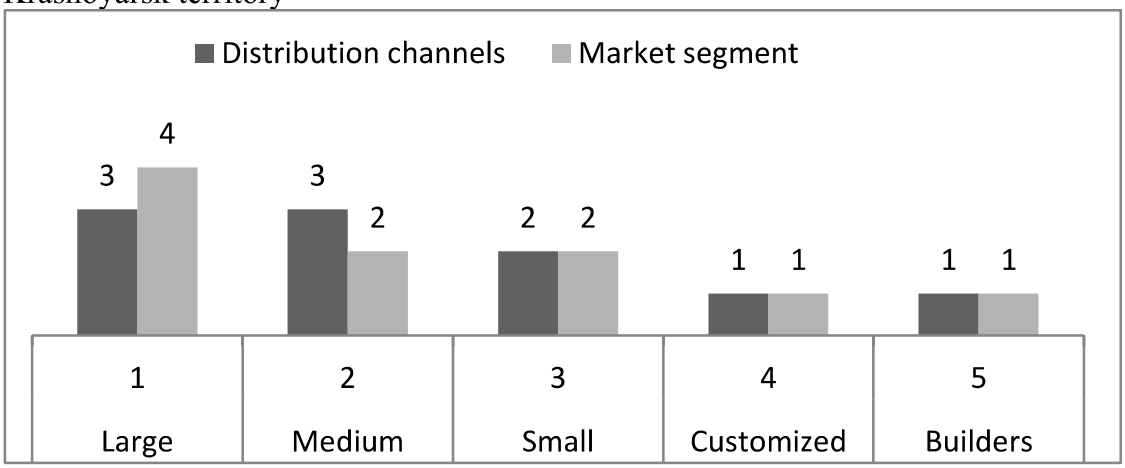
Group 4 includes small firms (up to 100 products per month). Production equipment is minimal (10 -15 items per shift), located in small workshops (20 - 50 m2). Sales offices either do not exist at all, or it is one and small. There is one or two persons in an installation team, who are often outsourced. Price segment is one. Distribution channels is one. There is no supply department, no partner programs, no discounts. There are no delays. The service level is low.

Group 5 includes window companies at construction companies. Production capacity is 100-1500 products per month (directly depends on the size of the construction company that created such a division). They provide a specific level of service for a construction company (they can take payment in square meters, have a large number of installation teams, and rarely carry warranty obligations for

commissioned objects). As a rule, they work in the "economy" segment, sometimes in the middle price segment. The distribution channel is one (the construction company that created the window company sometimes takes contracts from other construction companies). The supply department is built on the model of a construction company's supply. Partner`s programs are usually not needed. Discounts are given per square meters when purchasing is in cash, or deferred payments, or agreement to work on specific conditions.

The results of the authors` analysis of the strategic positioning of enterprises in the market of individualized products such as plastic windows are shown in Fig.2. It should be noted that this market structure is typical for the most large cities of Russia.

Figure 2. Map of strategic groups of competitors in the window market of the Krasnoyarsk territory



Source: authors` development

The results of the analysis show that the largest number of products are produced by medium-sized, small and customized firms. At the same time, they use 2-3 channels of stock movement, which suggests the possibility of using the principle of variability in the formation and selection of individualized products` supply chains. This will allow us to implement an important principle - the flexibility of supply chains.

SWOT analysis of companies in the market of individualized products made it possible to compare the strengths: reliable management, good technological skills, best production opportunities, with weak potential internal sides: weak sales network, weak marketing organization, lack of supply chain management strategy. Potential external opportunities such as ability to use technology for production of non-standard designs, possibility of rapid development in case of a sharp demand in the market, were compared with potential external threats such as growing demand of customers to reduce prices and improve quality. The analysis suggests that achieving an equilibrium between the strategic logistics requirements described above and operational constraints, in our opinion, will allow ones to form effective supply chains of individualized products.

The following specific features of the selection of supply chain participants, in our opinion, are key and typical for supply chains in the production of individualized

products on the market of plastic windows on the Krasnoyarsk territory and in other regions:

- individualized approach of companies to creating products and services that meet the requirements of a specific customer;
- modular design - using standardized modules in the production of individualized products, it is possible to reduce cost, while maintaining flexibility and individual approach, thereby gaining competitive advantages;
- use of "pull" type system in production and logistics;
- use of universal production equipment that can perform various operations, as well as changeover to other production operations;
- value chain management - involving suppliers located higher up the supply chain, creating value for the final product, optimizing participants' tasks and using partners' resources;
- "lean production" - inventory reduction along with rapid production and delivery become the main source of funds for enterprises of individualized products;
- organization of processes that require optimization of the order execution queue to prevent conflicts between different participants to meet individual customer requirements;
- integrated approach which embodies the concept of mass individualization in the supply chain in the production of individualized products, including management infrastructure, skills and competencies used.

Summarizing the results of research on the market of plastic windows on the example of the Krasnoyarsk territory, we can confirm that small and medium-sized enterprises, mainly forming dynamic supply chains and representing individualized enterprises, need logistics support. The logistics approach in their supply chains allows them to reach a new level of enterprises` profitability, and, therefore, will contribute to the development of such enterprises. This is an important aspect for development of a small business system in the region and the country.

3. DEVELOPMENT OF A DISTRIBUTED ASSEMBLY MODEL OF INDIVIDUALIZED PRODUCTS

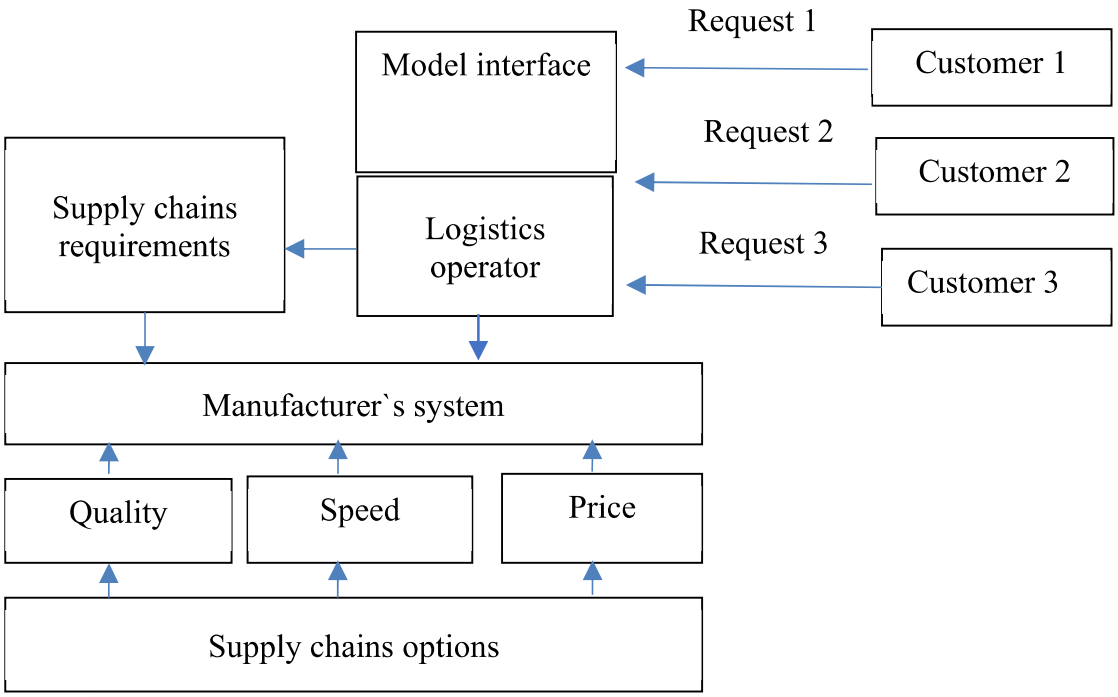
In order to digitalize the configuration of supply chains for individualized products by a customer, a distributed assembly model was developed, which differs from other models by having a flexible system for selecting participants in the supply chains of individualized products in accordance with customer requests.

To develop a model of interaction between participants in the supply chain of individualized products, we use the results of analysis of external and internal factors that affect functioning of such a supply chain. The results of analytical research of a customized product` market allow us to offer an idea of a distributed assembly of individualized products to create a chain model of customized products. This will make it possible to implement the main logistics requirements for such a chain as flexibility, efficiency and economic requirements of profitability of chain participants.

The idea of the distributed assembly model is supposed to integrate small and medium-sized businesses engaged in the production of individualized products into

the supply chain in the region. Orders from end customers are collected and processed in the general information field. At the same time, a supply chain is selected based on the customer's key parameters. The concept of a distributed assembly model is shown in figure 3.

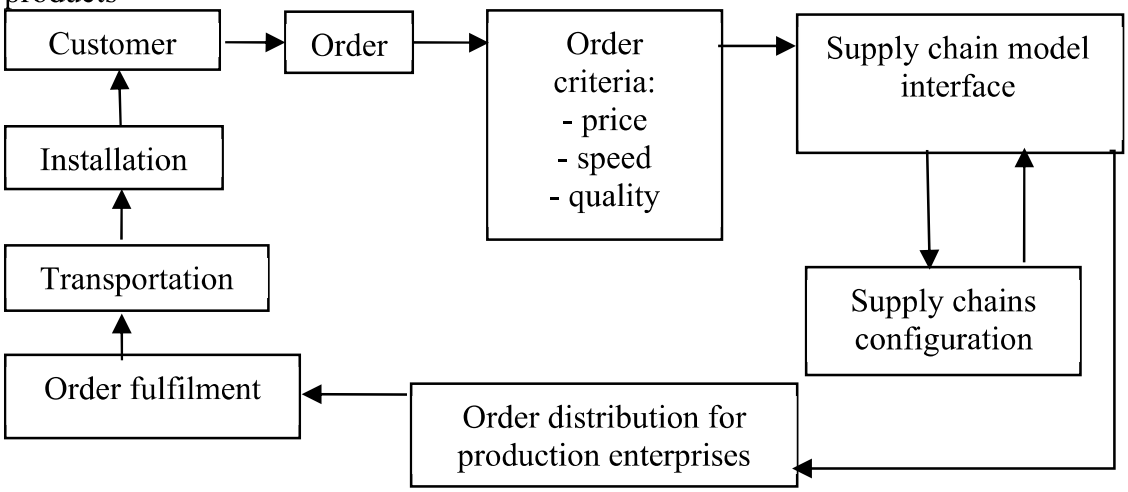
Figure 3. The concept of a distributed assembly model for converting customer`s requests into requirements for creating supply chains of individualized products



Source: authors` development

The concept is based on a mechanism for coordinating the requirements of customers for individualized products in price, quality and speed of order production. To implement these rather contradictory factors, a method of involving a customer in design of a supply chain has been applied. This is implemented by creating such subsystems as “interface”, “logistics operator”, “supply chain requirement” and “supply chain options”. In this case, location of producers and other subjects of the supply chain on the territory of the region is considered. Customers` requests are processed by a logistics operator using a computer interface, and a set of customers` requirements is formed with possible costs in the process of manufacturing components and an ordered product. Further, supply chains options of individualized products are formed through customers` key requirements – speed, price and quality. Then customers can choose an appropriate supply chain, taking into account their geographical location. However, it is important that a choice is made regardless of the size of an administrative division. Based on the concept, a distributed assembly model has been developed for the formation of supply chains of individualized products selected by the customer (Fig. 4).

Figure 4. Distributed assembly model for creating supply chains for individualized products



Source: authors` development

The actions of the participants in the supply chain of individualized products (final assembly plants, suppliers and manufacturers of components) are coordinated with the distribution network (order acceptance, installation and service organizations), where delivery, installation and installation services of the delivered products are performed. In addition, transport and warehouse resources of the logistics operator are used to deliver components to the manufacturer and finished products to the end customer. The most important link in the model of distributed assembly of individualized products is the link in the configuration of supply chains (Fig. 4).

Additional factors that determine feasibility of using the distributed assembly model are the following:

- by delivering components closer to the final assembly point of finished products, the logistics operator together with the supply chain companies reduces cost and time period from production to order implementation;
- in the distributed assembly model location constraint is eliminated. In production of components and finished products based on the distributed assembly model, free production capacities that exist in the network of supply chains of individualized products are mainly used;
- the supply chain becomes more flexible because the logistics operator has an ability to expand and reduce infrastructure of goods movement in the supply chain at a high speed in order to achieve competitive advantages of the supply chain;
- it is possible to distribute incoming orders among several manufacturers in the distributed assembly model, which reduces risk of failures, unlike traditional case of a single production site;
- by transforming the supply chain into a network, it is possible to use excess capacity of large producers, which are loaded during the execution of customer orders to a much lesser extent.

4. PRACTICAL APPROVAL OF A DISTRIBUTED ASSEMBLY MODEL OF INDIVIDUALIZED PRODUCTS

The distributed assembly model interface automatically selects the delivery optimization option based on location when distributing an order, but it allows a customer to choose a contractor independently, taking into account a profile type, type of hardware, number of shutters in the window, manufacturer's location, and production load. In this regard, a system requires daily updating of databases on the date of product release and the date when orders are accepted for production, ideally, “in a real-time model”.

The developed model of distributed assembly of individualized products was approved in the market of plastic windows, which allowed linking production and component enterprises of individualized products on a common information platform into a single network.

In the process of testing the distributed assembly model, main factors that determine internal and external environment of supply chain participants were identified, such as system complexity, uncertainty and variability of system parameters, conflict of participants` interests within the supply chain, dynamics and flexibility of the supply chain.

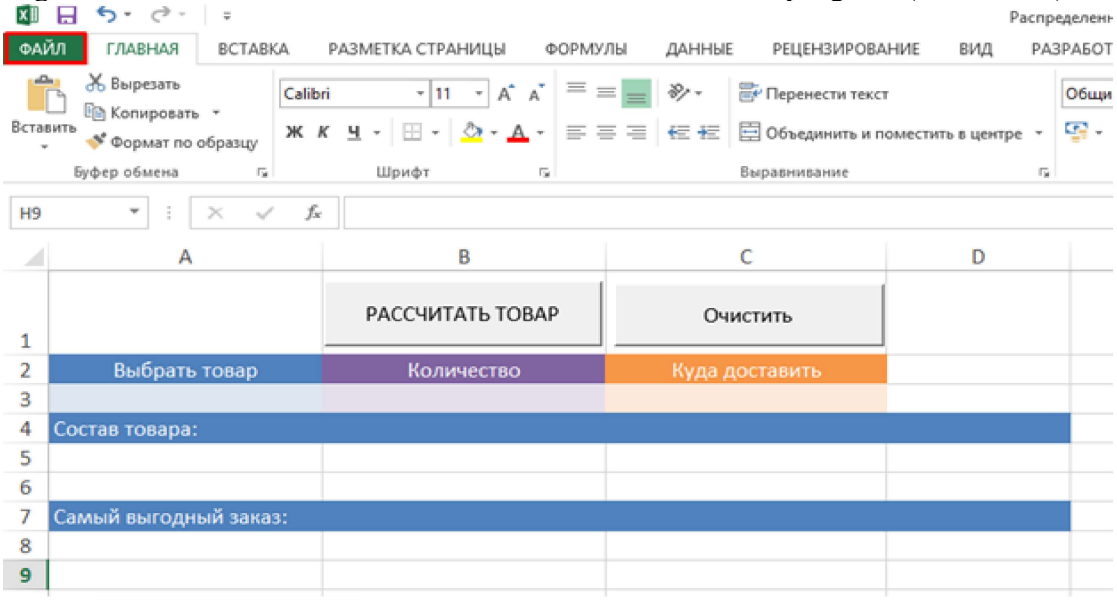
In order to minimize degree of these factors` influence on the processes of stock movement in the supply chains of individualized products, an interface for configuring the supply chains of individualized products in a distributed assembly environment was developed; it was called “The distributed assembly supply chain” (DASC). The interface is an Excel workbook with the extension “.xlsx” and is guaranteed to work in versions of Microsoft Excel.

Functional blocks of the interface algorithm and sequence of interface steps are as follows:

Step 1– select order parameter values based on the following criteria: price, speed and quality.
Step 2 – search for manufacturers that match the selected values.
Step 3 – select the product quantity and delivery address.
Step 4 – calculating the order cost.
Step 5 – select the smallest value of the order.
Step 6 – choose the fastest delivery of the product to order.
Step 7 – selecting the optimal supply chain.

The DASC interface consists of 4 blocks: 1 – customer order data analysis block; 2 – database – product composition; 3 – database – manufacturer; 4 – database for transportation – distance (Fig.5).

Figure 5. General view of the distributed build calculation program (screenshot)



Source: authors` development

When running the DASC interface in its program, the combinatorics method calculates possible delivery options for various components of the product from different manufacturers, taking into account the cost of delivery.

The DASC interface allows creating a variant of the optimal supply chain in accordance with the customer's order after calculating all combinations using the entered variables. Since customer orders for the final product are variable by product type and component composition for assembly, the DASC interface provides an ability to automatically select the option to build an order from different components, forming an individual supply chain for each order. An example of calculating the optimal supply chain in the DASC interface is shown in Fig. 6.

Figure 6. Screenshot of the calculating result of an optimal supply chain for premium products in Uyar (a small town in the Krasnoyarsk region)

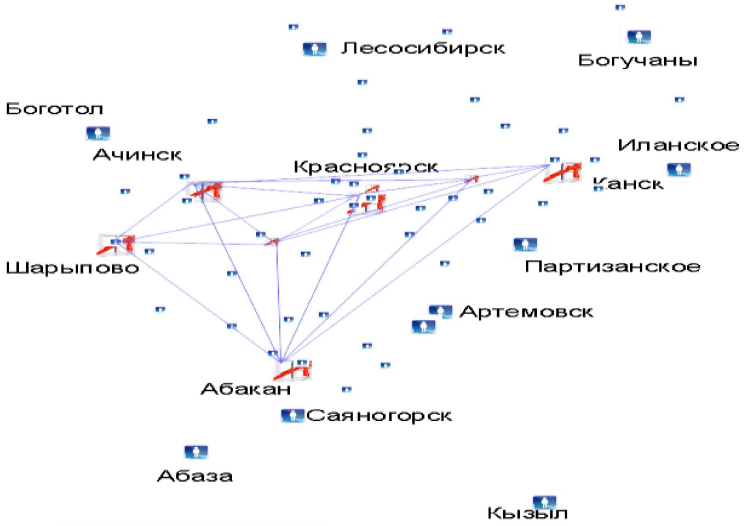
Выбрать товар	Количество	Куда доставить	
Окно премиум	3	Уяр	
Состав товара:			
Профиль	Стеклопакет	Фурнитура	
Премиум	Премиум	Премиум	
Самый выгодный заказ:			
Современные окна	ССК	Современные окна	
Профиль	Стеклопакет	Фурнитура	
Премиум	Премиум	Премиум	
7500	4500	3000	
Доставка:	Доставка:	Доставка:	
940	1000	0	
Сумма:	Сумма:	Сумма:	Итого
8440	5500	3000	16940
Самая быстрая доставка:			
Современные окна	ССК	Современные окна	
Профиль	Стеклопакет	Фурнитура	
Премиум	Премиум	Премиум	
7500	4500	3000	
Доставка:	Доставка:	Доставка:	
940	1000	0	
Сумма:	Сумма:	Сумма:	Итого
8440	5500	3000	16940

Source: authors` development

Thus, created automated module of distributed assembly – the DASC interface – helps to optimize the process of developing supply chains of individualized products in the conditions of distributed assembly.

Numerical experiments were performed to test the distributed assembly model using databases of manufacturers, product composition, and object locations for the Krasnoyarsk region. The competing production sites were considered for all manufacturers of plastic windows within the borders of the window cluster in the region (Fig. 7). Using the key parameter optimization algorithm: product quality, product price and order execution speed, optimal supply chains were calculated for any customer who placed an order for an individualized product.

Figure 7. Window cluster of the Krasnoyarsk region and the Republic of Khakassia



Source: authors` development

In the process of testing the algorithm for developing supply chains of individualized products in the distributed assembly model, five enterprises producing plastic windows in the Krasnoyarsk territory, which are the most typical for the market under consideration, were considered. There are three manufacturers' locations in this region: Krasnoyarsk, Abakan, Kansk, and several localities where potential customers of plastic windows for their individual houses and apartments live. At the same time, assessments of the effectiveness of individualized products supply chains were carried out in several variants of customer orders: profitable order at the lowest price criterion and fast delivery of the order to the customer by speed criterion. In addition, parameter of producers` profitability was evaluated in order to determine interest of supply chain participants.

The experiments consider typical situations when customers are located within the Krasnoyarsk territory at distances from 75 to 200 km from the producers` locations. Comparison of the same product cost from different manufacturers in different supply chains shows a deviation of the final price of the product on the order in the range of 2.5% to 19.2%.

In case of calculating efficiency of the supply chain at the customer's request “fast delivery”, selection of producers in the supply chain is performed, which allows reducing the delivery time by 36-44%.

When testing the distributed assembly model in terms of its profitability for small and medium-sized enterprises, the generalized economic indicators of five typical window market firms in the Krasnoyarsk territory were analyzed in two cases for comparison: in traditional supply chain (Tab. 2) and supply chains in the conditions of distributed assembly (Tab. 3).

Table 2. Performance indicators of individualized enterprises in the traditional supply chain

Indicators	**“Proyem”**	**“Avrora”**	**“Sovremennye okna”**	**“Comfort”**	**“Parnas”**
Revenue, RUB	2 450 000	1 470 000	4 900 000	490 000	1 500 000
Expenses, RUB	2 085 000	1 146 000	3 850 000	404 000	1 239 000
Profit, RUB	365 000	324 000	1 050 000	86 000	261 000
Profitability,%	17,5	28,3	27,3	21,3	21,1

Source: authors` development

Table 2 shows that the profitability of firms in the market ranges from 17.5% to 28.3%, and the volume of output ranges from 100 to 1000 products per month.

Table 3. Calculation of performance indicators for individualized enterprises in a distributed assembly model

Indicators	**“Proyem”**	**“Avrora”**	**“Sovremennye okna”**	**“Comfort”**	**“Parnas”**
Revenue, RUB	2 820 000	1 880 000	7 050 000	940 000	2 350 000
Expenses, RUB	2 268 000	1 512 000	5 640 000	760 000	1 895 000
Profit, RUB	552 000	368 000	1 410 000	180 000	455 000
Profitability,%	24,3	24,3	25,0	23,7	24,0
Change, %	39,9	-14,1	-8,4	11,3	13,7

Source: authors` development

The last line in Tab.3 shows change in profitability in the distributed assembly model supply chains compared to traditional supply chains (Tab.2). As one can see, some enterprises have improved their profitability indicators, while others have shown a decrease in profitability. This is quite an interesting result related to the production capacity of manufacturing companies: for small businesses, profitability has increased, and for larger enterprises, profitability has decreased. At the same time, both small and larger enterprises increased revenue, while costs for large enterprises decreased not as significantly as for small enterprises.

5. CONCLUSION

Manufacturing enterprises of small and medium-sized businesses operating in a dynamic market environment are in urgent need of effective methodological and practical tools for the formation and management of flexible supply chains, allowing them to quickly adapt to the needs of consumers and configure the supply chain for each order. The final customer is involved in the formation of such a supply chain by

selecting the product characteristics and / or supply chain characteristics that they need.

To develop and test the methodology for flexible configuration of production enterprises` supply chains from the consumer side, the regional market of plastic windows of the Krasnoyarsk region was investigated. This is a typical market for the production of individualized products, mass-demand products produced in large volumes, but taking into account the individual configuration for each product. In addition, the analysis of a large territory of the Krasnoyarsk region showed the potential to increase efficiency of redistributing traffic flows due to the final assembly of the product closer to the consumer.

The value of performance indicators of individualized enterprises in the distributed assembly model and their comparison with the performance indicators of individualized enterprises in the traditional supply chain shows that in the conditions of distributed assembly there is an increase in volume of finished products production and an increase in profitability by 11,3 – 39,9 % due to cost reduction at the small enterprises. Thus, producers received economic benefits, and consumers received ordered products at a lower price and faster delivery.

It can be argued that a new methodological tool – interface of the distributed assembly supply chain (DASC) – has been developed for the development and management of supply chains of individualized products based on the distributed assembly model, which allows customers to participate in the regional market in the configuration of supply chains by applying indicators of price, quality, speed of manufacture and delivery of individualized products.

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