EXAMINATION OF LOGISTIC PARAMETERS WITH AN INFLUENCE ON COST EFFICIENCY IN DELAYED (RELOCATED) ASSEMBLY

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Globalisation is a very important and topical problem that has a great many positive and negative effects. It can be evaluated in many ways, but it can be seen that globalisation is unavoidable. If we want to do something for the socio-economic development, our national benefit and our national identity, all we can do is to emphasise its positive effects and eliminate its negative effects. In this effort the logistic methods play a significant role, because logistic systems cannot be imported since they depend on local capabilities.

Delayed (relocated) production, globalised purchase and distribution are typical of globalisation. It means that the last phase of production is relocated close to the customer, which delays completing the production. All this applies to product assembly, packaging and the last operations of production. Part of the required components are provided by the parent company of the multinational company, companies specialised in manufacturing of components and bigger suppliers (which can provide the necessary technical and technological requirements) for the assembly of products. These companies represent world brands and provide the most important components. The biggest amount of components is provided by relocated suppliers (close to the assembly plants). Production, which becomes network-like, comprises the activities of assembling companies and suppliers. Naturally, this categorisation is oversimplified because e.g. a component-assembly plant can be on the one hand the supplier of the product-assembly plant, and, on the other, it has a large number of component and raw material suppliers. First a typical model of delayed production and globalised purchase will be examined. This model can be seen in Fig. 1.

![Figure 1. Structure of delayed production](image-url)
Delayed production is a structure that includes production of components and parts, assembly, packaging and commissioning.

The most common alternatives of delayed production are concerned with the last phases of segmented production. In these phases the last operations of the manufacture of components and assembly units are completed, which operations make the purchase (from distant suppliers) much easier and more reliable. The manufacture of plastic parts is also a typical delayed production, because delayed production can produce the required quality of components with adequate tools, and the transportation of a relatively high volume of components can be eliminated.

The assembly of final products or components is the most decisive part of delayed production. Relocated production and relocated packaging can be installed at the site of the assembly plant. Relocated production and packaging can also be installed in the distribution store, if several similar products are packaged and commissioned at these places. The integrated model of globalised purchase and distribution can be seen in Fig. 2.

![Diagram of integrated model of globalised purchase and distribution](image)

**Figure. 2. Integrated model of globalised purchase and distribution**

The division of the purchase system into two levels of suppliers is very common in globalised purchase. Primary suppliers provide for customers assembly units and components, which may be their own components or components obtained from secondary suppliers (part of the components are built-in, others are only collected and stored). Distribution of products manufactured by relocated production may be achieved through distribution stores.
In globalised purchase and distribution generally a secondary supplier provides components for several primary suppliers, and a primary supplier obtains components from several secondary suppliers and delivers them to several relocated manufacturers. A relocated manufacturer receives assembly units and components from several primary suppliers and one type of products can be stored in several distribution stores, and finally an end user can get one type of product from several distribution stores.

An analysis of the role of logistics in the globalised economy:

• The logistic methods and logistic systems play a major role in relocated (delayed) production because
  - the most important parameters (having an influence on competitive position)
    - run-times,
    - stocks,
    - costs
  are determined by the development level of the logistic system to a large extent,
  - logistic systems and methods are determined by the local abilities to a large extent,
  - a dynamically changing product structure and volume require the intensification and reengineering of the logistic system,
  - the development of a logistic system may be an important factor in the improvement of supply potentials.

• Enhancing the potentials of domestic suppliers is our national interest because
  - it encourages the stabilisation of relocated production,
  - they are dominant members of the Hungarian industry and economy.
  It is very important in terms of the national economy that

• more and more relocated production should be established because
  - it creates jobs,
  - it provides good business opportunities for domestic suppliers,

• relocated production should be economically stable, also when labour costs are higher in a given country, which means that we have to utilise the potentials of delayed production,
  - the quality of logistic services should be improved, costs should be decreased by logistic equipment,
  - research and development centres should be established, well qualified employees (skilled and qualified labour) should be provided.

The conditions of stable economic operation in delayed assembly are to be examined. Delayed and non-delayed assembly will be compared in a simplified model of production of a world brand product family.

The simplification means that in both cases the multinational company manufactures the most important components (typical for a given world brand) in only one plant, or collects these from a nearby supplier.
Fig. 3 shows the structure of non-delayed assembly.

In this case the assembly and the manufacturing of the most important components are realised in one plant, or close together. The biggest part of components and assembly units are purchased from suppliers close by or further away. The final products are distributed – sometimes through distribution stores – to customers world-wide.
Fig. 4 shows delayed assembly. In delayed assembly the assembly plants are established very close to end users. It results in the fact that the special requirements of products are taken into account (e.g. national traditions, geographical specialities, etc.). In this case the most important components are provided by the parent company of the multinational company or nearby suppliers. The other suppliers – as many as possible – should be close to the relocated assembly plants. When the costs of delayed and non-delayed assembly are compared, the costs have to be divided into cost components. The total costs are:

\[ K = K_{SG} + K_{SB} + K_{SC} + K_{v} + K_{ML} + K_{m} + K_{ML} + K_{D} \]  

(1)

where:

- \( K_{SG} \) technological costs of self-production,
- \( K_{SB} \) logistic costs of self-production (internal transportation and storage costs),
- \( K_{SC} \) external logistic costs of self-production (costs of transportation between manufacturing place and assembly plant),
- \( K_{v} \) purchase costs (sales price of supplier), not including the transportation costs and storage costs of assembly,
- \( K_{ML} \) logistic costs of purchased parts (transportation and storage costs at end user),
- \( K_{m} \) technological costs of assembly,
- \( K_{ML} \) transportation, storage, loading, etc. costs inside the assembly plant (internal logistic cost),
- \( K_{D} \) distribution costs of assembled products.

The use of delayed assembly will be economical and justified if the total costs \( K_1 \) are less than the costs of non-delayed assembly \( K_2 \).

\[ K_1 < K_2 \]  

(2)

The inequality (2) must be satisfied in the decision making about relocation and also during operation.

If \( K_1 < K_2 \) and \( \Delta K = K_2 - K_1 > 0 \)  

(3)

is satisfied, or an expression (4) can be found, where

\[ \Delta K^* = K_2 - K_1 > \Delta K \]  

(4)

i.e., the assembly plant will be relocated, and the national interests will be injured.
Before the detailed analysis the parameters having an influence on cost components are examined. The relevant parameters having an influence on delay are as follows:

- $Q$ production volume, which is lower in delayed assembly than in more concentrated non-delayed assembly,
- $k_m$ labour costs, which are more favourable in delayed assembly,
- $L$ logistic development level, logistic efficiency, which can be developed in delayed assembly,
- $L$ distance of transportation, which can be shorter in supply and distribution of delayed assembly,
- $m$ number of suppliers, which is higher in delayed assembly.

Cost functions depending on production volume:
Self-production costs: $K_{sg} = K_{sg}(Q)$, Assembly costs: $K_u = K_u(Q)$,

This function shows a decrease as compared to the linear (Fig. 5).

![Figure 5. Cost functions depending on production volume](image)

All cost components depend on labour costs approximately linearly, depending on the properties of the products, and the mechanisation of individual processes (Fig. 6).

![Figure 6. Cost functions depending on labour costs](image)
Costs depending on logistic development level and logistic efficiency are as follows:

Logistic costs of self-production: $K_{SB} = K_{SB}(P_L)$; external logistic costs of self-production: $K_{SK} = K_{SK}(P_L)$; logistic costs of purchased components: $K_{VE} = K_{VE}(P_L)$; internal logistic costs of assembly: $K_{ML} = K_{ML}(P_L)$; distribution costs of final products: $K_D = K_D(P_L)$;

Cost functions decrease significantly with an increase in logistic development level (Fig. 7).

Figure 7. Cost functions depending on logistic development level

The amount of reduction of cost functions influenced by development level and efficiency of the logistic system depends on the type of products and changes in product volume. Generally this effect is more significant in external logistic systems.

Basically the distance of transportation has an effect only on the costs of external logistic activities: external logistic costs of self-production: $K_{SK} = K_{SK}(L)$, logistic costs of purchased components: $K_{VE} = K_{VE}(L)$, distribution costs: $K_D = K_D(L)$. The cost functions are linear (Fig. 8).

Figure 8. Costs depending on distance of transportation
The grad ient of the cost function depends on mode of transportation, mass of products, volume, handling mode, utilisation of transport vehicles.

The number of suppliers has an effect only on the logistic costs of purchased components:

\[ K_{VE} = K_{VE}(m) \]

![Figure 9. Cost function depending on number of suppliers](image)

The cost function (Fig. 9), which depends on the number of suppliers, shows an increasing tendency, the degree of which depends on the standard of the logistic system. Let us compare the cost components and examine how the optimum operation of suppliers and the related logistic methods can achieve, maintain and increase cost-efficiency in relocated assembly.

If the costs of component supply are analysed,

\[ K_{SG1} + K_{SB1} + K_{SK1} + K_{V1} + K_{VL1} = K_{SG2} + K_{SB2} + K_{V2} + K_{VL2} \]  

(5)

the following facts can be stated:

- Costs of transportation to assembly plant do not exist in non-delayed assembly because self-production and assembly are completed at the same place, so

\[ K_{SK2} = 0 \]  

(6)

- The costs of delayed assembly are lower than the costs of non-delayed assembly. If it is supposed that the same components were manufactured (self-production) in the last case, so

\[ K_{SG1} = K_{SG2} \quad \text{and} \quad K_{SB1} = K_{SB2} \]  

(7)
it would be required that

\[(K_{V2} + K_{VL2}) - (K_{V1} + K_{KL2}) > K_{SK1}\]  \hspace{1cm} (8)

This means that the purchase and logistic costs of purchased components in delayed assembly should be less in order to compensate for the high transportation costs of self-manufactured components.

It is very important that the components provided by nearby suppliers should be as cheap as possible in relocated assembly. If it is taken into account that the purchase costs at suppliers

\[K_v = K_{vg} + K_{vb}\]  \hspace{1cm} (9)

consist of manufacturing costs \(K_{VG}\) and logistic costs of supply \(K_{VB}\), it can be seen that

- suppliers have a major role in relocated assembly,
- suppliers have a great influence on logistic costs,
- continuous development of logistic methods may be a good opportunity for compensation for increasing production costs caused by increasing labour costs.

If the assembly costs and their major part, the internal logistic costs are examined,

\[K_{K1} + K_{ML1} < K_{K2} + K_{ML2}\]  \hspace{1cm} (10)

then in the beginning inequality (10) can be satisfied, but the increasing labour costs have to be compensated for by logistic methods.

Similarly to (10) for distribution costs:

\[K_{D1} < K_{D2}\]  \hspace{1cm} (11)

the inequality will be satisfied, and shows a significant

\[\Delta K_D = K_{D2} - K_{D1}\]  \hspace{1cm} (12)

difference, compared to delayed assembly, which benefits the satisfaction of (2).

After the analysis the conclusions are as follows:

- domestic suppliers - as nearby suppliers - have a major role in the establishment and operation of domestic relocated assembly plants,
- the development level of the production system and related logistic system have a significant role in the optimum and cost-effective operation of suppliers,
- the logistic system has a major role both for the suppliers and the product assembly and distribution processes.
The above facts result in the following major positive effects and elimination of negative effects of globalised production:

- Suppliers, because, on the one hand, they support relocated assembly by optimum operation, and on the other, their profitable operation intensifies the national economy and plays a major role in the creation of new jobs,

- The development level of logistic systems and methods is decisive for the success of suppliers, on the other hand, suppliers have an influence on the success of the assembly and distribution of final products, and play a major role in enhancing productivity.

The supply activity can be made more efficient by the following logistic methods:

- Application of electronic business,
- Establishment of clusters, virtual logistic companies for supporting supply and distribution activities,
- Establishment of JIT and KANBAN supply,
- Establishment of distribution stores and consignment stores,
- Monitoring of transport vehicles by GPS (Global Positioning System),
- Optimisation of production logistic processes of suppliers, application of logistics integrated production scheduling.

References