

# Research on Logistics Time Management Decision Based on Supply Chain

ShiMing Liu, Huihong Chen and Ziyu Hu

Guangzhou Panyu Polytechnic, Guangzhou 511483, China

**Abstract.** With the development of society and the continuous advancement of science and technology, the uncertainty of demand is getting bigger and bigger. The competition of enterprises has shifted from cost and quality to time. Who can respond to customers in a shorter time and meet the needs of customers? Demand can win the competition. This article first analyzes the characteristics of time management and time competition in the supply chain. It finds the time bottleneck of the supply chain, classifies the time bottleneck, analyzes the causes and evaluation, and finally puts forward the implementation of countermeasures.

## 1. Introduction

In the business environment of the company, although the company has realized the importance of responding quickly to customers, the factors form the supply chain response time. There are the constraints to shortening the supply chain response time, which effectively shorten the supply chain response time. There is no relevant theoretical explanation and no correct understanding of the supply chain response time. This article identifies the time bottlenecks in the supply chain, classifies the time bottlenecks, analyzes the causes, and evaluates them. Finally, it proposes implementation measures.

## 2. Constraints on the Management of Logistic Time

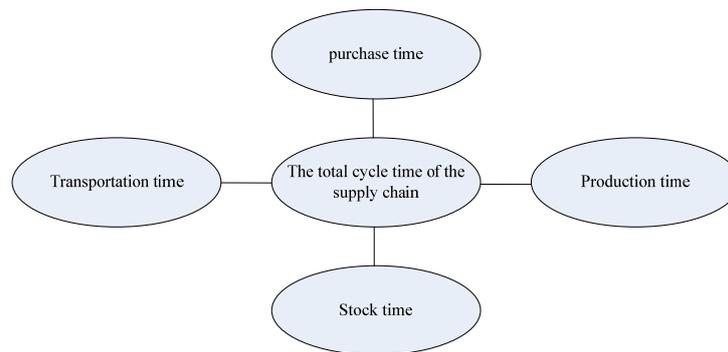
### 2.1. Summary of Constraint Theory and Supply Chain Time Bottlenecks

Time-based competition should consider the overall time period of the system. Compressing time from product design, procurement, manufacturing, assembly, distribution, and even human resources, etc., has become the consensus of time research. This does not mean that the supply chain time spent anywhere must be equally important. Although the time compression of different links can have a good impact on the company, the impact size is very different.

The Theory of Constraints (TOC) suggests that any system can be thought of as a series of rings that are interlocked with a ring. The strength of this system depends on its weakest link, not its strongest link. We must start with the weakest link, that is, the bottleneck (or constraint) to achieve a significant improvement. Constraint theory is also applicable to supply chain. It can use the idea of constraint theory to study the time management problem in the whole supply chain system.

In the supply chain, if any link or activity hinders the company from responding to customers at a faster rate, or if it has the greatest influence on the length and stability of the supply chains overall process cycle, then it is this supply's bottleneck in the chain.





**Figure 1.** The time structure of the total cycle of the supply chain

### 2.2. Types of Time Bottlenecks in the Supply Chain

Since the concept of bottleneck was put forward, it mainly existed in production management. The bottleneck defined in production management as a great correlation with the time bottleneck in the supply chain, because the existence of a resource bottleneck inevitably leads to a decrease in response speed. Therefore, the resource bottleneck is a time bottleneck. But this is only a very small aspect, and the time bottleneck of the supply chain has a broader meaning. In order to thoroughly investigate the time bottleneck of the supply chain, it is necessary to study the basic types of bottlenecks.

(a) Capacity-based time bottlenecks. The processing capacity of the bottleneck linking with other links does not match, which limits the output rate of the entire supply chain, resulting in slow response and capacity-type bottlenecks.

(b) No value-added time bottlenecks. The bottlenecks consume more time but do not generate any value and should be eliminated.

(c) Scheduling bottlenecks. The bottleneck is independent, which can be carried out in parallel with other links. However, it adopts a serial method in practice, which leads to reduced response speed. It is a scheduling bottleneck.

(d) Interface bottlenecks. Because of the unreasonable interface settings between two consecutive links, the seamless connection cannot be achieved, resulting in lengthy time for information transmission and interaction, which affects the response speed of the supply chain as an interface bottleneck.

In practice, some time bottlenecks may be more complex, and it may be a combination of several basic forms.

### 2.3. Analysis of the Cause of Time Bottleneck in Supply Chain

There are many reasons for the time bottlenecks in the supply chain, which can be summarized as follows:

(a) Supply of materials. In the supply chain, due to material supply shortages, delays, and quality problems in the purchased materials, it is easy to cause production adjustments or even stop the line, creating a time bottleneck in the supply chain.

(b) Resource factors. Those resources that do not match the production capacity of other links and whose actual production capacity is less than or equal to their production load or their demand (maybe talents, facilities and equipment or funds, etc.) will limit the output rate of the entire supply chain system. It will inevitably become a time bottleneck affecting the supply chain response speed.

(c) Quality factors. In production, failure to discover unqualified products in time and prevent them from entering the next process can result in rework or scrapping of nonconforming products, which is a waste of time. Therefore, quality problems are also an important cause of time bottlenecks.

(d) Facilities layout factors. One of the key factors affecting time is the arrangement of facilities. Improper arrangement of facilities will lead to inefficient workflows and time bottlenecks.

(e) Process setting factors. Many time bottlenecks in the supply chain are caused by improper process settings.

The above factors are the main causes of time bottlenecks in the supply chain. There are also some interactions between these factors. For example, a good information environment can significantly promote cooperation and exchange between supply chain node enterprises. In table 1, it summarizes the relationship between these factors and the four time bottlenecks.

**Table 1.** The Time Bottlenecks of Four Supply Chains and Their Causes

|                       | Resource Factor | Material Factor | Facility Arrangement | Quality Factor | Batch | Process | Uncertainty | Cooperation | Information |
|-----------------------|-----------------|-----------------|----------------------|----------------|-------|---------|-------------|-------------|-------------|
| Scheduling bottleneck |                 |                 |                      |                | √     | √       |             | √           | √           |
| Capability bottleneck | √               |                 | √                    |                |       | √       | √           |             | √           |
| Interface bottleneck  |                 | √               | √                    |                |       | √       | √           | √           | √           |
| No value bottleneck   |                 |                 | √                    | √              | √     | √       | √           | √           | √           |

### 3. Evaluation method of time bottleneck in supply chain

#### 3.1. Value Evaluation Method

In the supply chain, the ultimate goal of time compression is to gain higher profits and gain competitive advantage. In fact, there are only two direct results: First, cut unnecessary links and shorten the overall process cycle length (TCT) of the supply chain; second, increase the processing capacity of the entire chain to increase the supply chain. To output rate (V), time compression is through these two aspects to reduce the in-process inventory, improve the efficiency, achieve higher market share and product prices, and improve the response speed to customers to achieve its ultimate strategic value. We evaluate the value of this bottleneck with the weighted value of the bottleneck. It reduced V and TCT improvement rate at a certain cost, as shown in formula (1):

$$VA_i = a(V_i - V_0)/V_0 + b(TCT_0 - TCT_i)/TCT_0 \quad (1)$$

$VA_i$ : Value factor of the  $i$ th time bottleneck in the supply chain,  $i=1, 2, \dots, n$ ,  $n$  is the number of time bottlenecks;  $V_i$ : output rate of supply chain after mitigation of  $i$ th bottleneck;  $V_i \leq V$ ,  $V$  is the supporting ability required by other links in the supply chain.  $V_0$ : reduce supply chain output rates before;  $TCT_i$ : the length of the overall process cycle of the supply chain after the elimination of the  $i$ th bottleneck;  $TCT_0$ : reduce the length of the overall process cycle of the supply chain before;  $a, b$ : weight  $(a + b)/2 = 1$ . The following two points should be noted when using this method to evaluate the value of time bottlenecks:

(a) Determining the weights of  $a$  and  $b$

The improvement of  $V$  and  $TCT$  determines the value of the meaning of the supply chain to determine the value of  $a$  and  $B$ . A significant weight is relatively high. In fact,  $V$  and  $TCT$  reflect the two levels of macro and micro:  $TCT$  represents process time, the significance of which is to eliminate non value-added activities and respond faster to specific orders. The output rate  $V$  represents the whole supply. In view of the gap between the output rate  $V$  of the supply chain and the overall market demand rate, if the  $V$  is very close to (or exceed the market demand rate), the  $A$  should take a smaller value (or zero). If  $V$  is far less than the market demand rate, then the improvement of  $V$  is more significant to supply chain,  $a$  and  $b$  should be taken as a higher value.

(b) Determining  $(V_i - V_0)$  and  $(TCT_0 - TCT_i)$

Here we draw on the framework model of lead time proposed by Emilio Bartezzaghi, because in the calculation formula of  $VA_i$ , the determination ( $TCT_0-TCT_i$ ) is more complicated, while  $V_i-V_0$ ) is easier to measure. First, it is assumed that the lead time of any link in the supply chain can be regarded as seven elements:

$$LT=SU+Q+R+PS+SY+NB+WTM \quad (2)$$

Among them, SU is the adjustment preparation time before processing; Q is the waiting processing time; R is the actual processing time; PS is the time for handling the unexpected event; SY is the waiting time due to the need to cooperate with other processes; NB is a buffer for inventory. WTM is the waiting time before transferring to the next link (related to transfer batches).

$(TCT_0-TCT_i)$  is easier to determine. Using this lead time composition model, the amount of change in each time element after the improvement of the bottleneck can be analyzed. And the value factor of this bottleneck can be determined using the formula of  $VA_i$ , because the specific values of  $(V_i-V_0)$  and  $(TCT_0-TCT_i)$  can be calculated from the above analysis. The company chooses the most critical bottleneck to break through and then sorts the bottleneck according to the size of  $VA_i$ .

### 3.2. Matrix Graph Method

The matrix graph can be used to evaluate some time bottlenecks which are not easy to evaluate quantitatively after identifying the time bottlenecks in the supply chain, as shown in figure 2. In the diagram, the horizontal coordinate is the bottleneck's influence on the final value, and the vertical coordinate is the bottleneck's magnification and elimination difficulty. The difficulty and influence coefficient of time bottleneck elimination are expressed as degree coefficients, which are  $N_i$  and  $Y_i$  respectively, and the reciprocal of them is bottleneck damping.

**Table 2.** Time bottleneck evaluation matrix

|                                      |                                      |
|--------------------------------------|--------------------------------------|
| Low impact<br>Difficult to solve III | Large impact<br>Difficult to solve I |
| Low impact<br>Easy to solve IV       | Large impact<br>Easy to solve II     |

In Table 2, the time bottleneck of the first quadrant is mainly caused by the scarcity of environment or resources, and the degree of difficulties and impacts are large. For such bottlenecks, enterprises should attach great importance to them. Once the environment has opportunities, they should immediately seize it. The bottleneck of the second quadrant is because they are less difficult to eliminate. But after the solution, it plays a greater role in the improvement of the final value of the enterprise. It is a time bottleneck that should be limitedly solved. The bottleneck of the third quadrant is due to the lesser degree of influence and the difficulty in solving the problem. Enterprises may temporarily not consider it. The bottleneck of the fourth quadrant is less difficult to solve, and the degree of influence is also relatively small, which is relatively easy to solve.

## 4. Logistics Time Management Decision Analysis

Applying the time-based bottleneck identification method of the supply chain based on value analysis has been proposed in related literature. We can identify the time bottlenecks of each company in the supply chain, identify the time bottlenecks in order to optimize the overall response time of the supply chain. The causes of each bottleneck are targeted to reduce the causes of each time bottleneck.

In order to obtain time competitive advantage, logistics time compression based on the supply chain can be divided into two modes. The first mode is called episodic time compression. This type of time compression is mainly through the increase of resources and the expansion of the organization scale. The second mode is called connotative time compression, which is to find the internal potential

mainly by keeping the quantity of resources unchanged, and obtaining the time advantage and time value through the integration and optimization of the supply chain.

The core of logistics time management based on the supply chain is the time compression strategy, which is to find various means to compress and reduce the non-value added time of the supply chain business to increase the time value of the supply chain. The strategic framework of logistics time management based on supply chain includes two levels of supply chain structure reengineering and operational strategy reengineering. Its goal is to realize the time compression of logistics and information flow in two dimensions.

(a) Time-compressed structure reengineering at the operational strategy level of the supply chain emphasizes the concept and method of process improvement. The operational strategy focuses on the operational level process.

Common strategies include quality management, breakthrough of capacity bottlenecks, determination of reasonable processing batches based on bottleneck capacity, optimization of facility layout, planned adjustments and changes, and machines maintenance and so on.

(b) Time compression of the supply chain structural reengineering can be further divided into macro structural reengineering and micro structural reengineering. The first is to reconstruct the macro structure which decides the form of the supply chain node and considers which type of company to use as a partner. After the partners are included in the supply chain, the macro structure of each company must also be adjusted accordingly, including information sharing, process reorganization, and optimization of the supply chain structure. The goal is to build a responsive supply chain network.

Microstructure reengineering emphasizes on the overall interests of the established supply chain alliance, macro-coordination, optimization of the whole, better realization of customer value, and enhancement of the time competitiveness of the entire supply chain. The main methods and strategies covers Information Engineering and Information management, Concurrent Engineering and Matrix Management, Flexible management, System Engineering and Integrated Management. The reengineering of supply chain through structural reengineering and operation strategy is mainly to achieve two-dimensional time compression. The first one is the compression of logistics time and the compression of information flow time. The goal of logistics time compression is first to meet the time requirement of the market for supply chain. Secondly, it is necessary to consider the appropriate number of logistics. On this basis, the logistics cost should be reduced as much as possible. The time compression of information flow is not only reflected in improving the speed of information transmission, but also more importantly in the ability to extract useful information.

By synthesizing the above-mentioned operational tactics, the overall strategy of logistics time management based on the supply chain is obtained. Based on this, the actual operation or simulation is used to analyze the supply chain's member companies and the entire supply chain. Performance is evaluated and adjusted dynamically according to different product types and demand types. In the process of designing and adjusting operational strategies, it is also necessary to comprehensively consider goals such as costs and customer service levels in addition to the response time objectives of the supply chain.

## 5. Summary

This article can theoretically promote the study of supply chain time. In reality, it can make supply chain companies have a clear understanding of the time resources they consume. How to reduce time bottlenecks fundamentally improve the speed of supply chain response to market demand. The guiding significance makes supply chain companies competitive in a rapidly changing market.

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