Identification of Emergency State and Obtaining of Optimal Scheduling Scheme for a Supply Chain System with Continuous Demand[1)]

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Abstract This paper discusses identification of the emergency state and the optimal algorithm of dispatch scheme for a supply chain system (SCS) with continuous demand. In a collaborative supply chain network, a manufactory may receive raw material from several suppliers. Once these suppliers are not able to meet its demand completely, the SCS is then in a state of emergency. What this paper has studied indicates that there exists an efficient method to judge whether the SCS is in this kind of state. Furthermore, this paper presents an optimal algorithm and the corresponding mathematic proof for the system not in an emergency state.

Key words Supply chain, continuous demand, supplier, emergency

1 Introduction

In a supply chain network, a manufactory may receive raw material from several suppliers. When the supply-capacity and lead-time of each suppler are known, whether there exists a feasible dispatch scheme depends on the specific type of demand of the manufactory. There are two typical types of demand, i. e., discrete demand and continuous demand. Discrete demand means that demand of the manufactory takes place in multiple stages, and this kind of demand frequently appears in assembly systems, for example, in a MRP(material requirements planing) system, the demand of material often takes place in different stages; continuous demand indicates that demand is continuous in a duration. And it often appears in a continuous production system. Apparently, different types of demand will result in different dispatch problems.

According to the characteristics of continuous demand, this paper discusses the identification of emergency state and the optimal algorithm of scheduling scheme for a supply chain system. This problem has a strong background of application. For example, the supply of fuel in some manufactory in Nanjing induces a typical multi-supplier continuous demand problem. The fuel required by the manufactory is to be offered by multiple suppliers, and the velocity of consumption is nearly steady (i. e., the velocity is a constant). Because the shortage will interrupt the process of production, which will finally cause large losses, the identification of emergency state and obtaining of optimal scheduling scheme seem to be very important. This kind of problem can be depicted as follows:

Manufactory A has continuous demand for some material in a period of time in the future. $A_1, A_2, \cdots, A_n$ are n suppliers being able to offer the needed material. With each depot A_i, we associate an available material quantity (capability) $x_i(>0)$, $i=1,2,\cdots,n$. A is the destination, which has a constant rate of material demand v in a duration $[s,f]$. Let t_i denote the lead-time from A_i to A. Our problem is to find conditions to determine whether the SCS is in a state of emergency. Further, we should give an optimal dispatch algorithm (i. e., deciding suppliers to participate in offering material and the quantity of the material provided by each selected supplier).

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2 Relatied definitions

Before we define the state of emergency, we assume the followings.

1) A has a total demand x in $[s, f]$. It means that $x=(f-s)v$, or $f=s+x/v$.

2) $0\leqslant t_1\leqslant t_2\leqslant\cdots\leqslant t_n\leqslant f$. The problem excludes those suppliers whose lead-time exceeds the latest demand time, i. e., f.

3) $\sum_{i=1}^{n} x_i \geqslant x$. It assumes the quantity of all available material of all suppliers is not less than x.

According to the above depictions, the dispatch scheme is to decide which suppliers to participate in offering material, and how much material to be provided by each selected supplier. Therefore, any scheme can be denoted as follows:

$$\varphi = \{(A_{i_1}, x'_{i_1}), (A_{i_2}, x'_{i_2}), \cdots, (A_{i_m}, x'_{i_m})\} \tag{1}$$

where $0<x'_{i_k}\leqslant x_{i_k}$, $\sum_{k=1}^{m} x'_{i_k}=x$, $i_1, i_2, \cdots, i_m$ is an arrangement of the sequence $1,2,\cdots,n, m\leqslant n$. According to (1), there are m suppliers, $A_{i_1}, A_{i_2}, \cdots, A_{i_m}$ that will provide the material, and the quantity is $x'_{i_1}, x'_{i_2}, \cdots, x'_{i_m}$, respectively.

Definition 1. A scheme φ is feasible, if for $\forall t\in[s,f]$,

$$\sum_{k\in\{j \mid t_j\leqslant t, j\in sub(\varphi)\}} x'_{i_k} \geqslant (t-s).v \tag{2}$$

where sub(φ) denotes the set of subscripts of the suppliers associating with the scheme φ. Accordingly, $sub(\varphi)=\{i_1, i_2, \cdots, i_m\}$. The left-hand side of (2) means the quantity of material having reached A at t according to scheme φ, and the right shows the consumed quantity from the start time s to time t.

If no feasible scheme exists, then the supply is not able to meet the continuous demand. In this situation, the SCS is called to be in a state of emergency, and we need some specific emergency method to deal with it. These emergency measures will be discussed in another paper. Our paper, however, involves: 1) determining whether the SCS is in a state of emergency by giving the determinant conditions, and 2) proposing an optimization scheme, when the SCS is not in an emergency state. Let Π denote the set of all schemes that are feasible for s, and we have the following definition:

Definition 2. The SCS is in the state of emergency if no feasible scheme exists (i. e., $\Pi=\phi$) .

In order to give a understanding of the above concepts, we present an example as follows Table 1.

Table 1 Lead time and available material of each supplier($x=400, v=20, s=6, f=26$)

	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
t_i	2	4	5	8	10	12	15	16	24	25
x_i	50	10	100	90	120	90	140	200	120	110

Table 1 presents some data including the quantity of demand, consumption velocity, start-time, finish-time, and relative data of 10 suppliers. For example, $\varphi_1=\{(A_1, 10), (A_3, 60), (A_6, 90), (A_7, 110), (A_8, 130)\}$; it is easy to see $sub(\varphi_1)=\{1,3,6,7,8\}$. Further, when $t=10$, $\sum_{k\in\{i \mid t_i\leqslant t, i\in sub(\varphi_1)\}} x'_k = x'_1+x'_3=70<(t-s)v=(10-6)20=80$. That is to say, when $t=10$, (2) does not hold, therefore φ_1 is not feasible. However, we should not conclude that no feasible scheme exists for the SCS only because φ_1 is not feasible. In fact, there does exist feasible schemes.

3 Identification of emergency state

Apparently, the key to determine the state of the SCS is to find the existence of feasible solution. The following theorem gives the existence condition of feasible schemes. In order to illuminate the problem easily, without loss of generality, we assume $i_0=0, j_0=0$, $x_0=0, y_0=0, \sum_{i\in\phi} x_i=0, \sum_{i\in\phi} y_i=0$ when necessary.

Theorem 1. Feasible solutions exist for the SCS (i. e., $\Pi\neq\phi$), if and only if $\forall k\in\{1, 2,\cdots,n\}$

$$\sum_{i=0}^{k-1} x_i \geqslant (t_k - s)v \tag{3}$$

Proof. "$\Rightarrow$"(reduction to absurdity): if $\exists k, \sum_{i=0}^{k-1} x_i<(t_k-s)v$, we consider two situations.

When $k=1$, (3) does not hold. We can deduce $0<(t_1-s)v$, i. e., $t_1>s$. Therefore, when $t=s+\varepsilon$(ε is a very small positive number, such that $s+\varepsilon<t_1$), for $\forall\varphi$, (2) does not hold. Therefore, no feasible scheme exists for the SCS, and the result is contradictive to assumption.

When $k>1$, we assume $t_k^-=t_k-\varepsilon$(ε is a very small positive number), and we have $\sum_{i=0}^{k-1} x_i < (t_k^- - s)v$. In this case, for any scheme φ(see (1)), it has $\sum_{i\in\{j\mid t_j\leqslant t_k^-,\ j\in sub(\varphi)\}} x_i'\leqslant\sum_{i=0}^{k-1} x_i< (t_k^- - s)v$. Therefore, when $t=t_k^-$, (2) does not hold, and thus the scheme φ is not feasible. The result is contradictive to assumption.

"$\Leftarrow$" we design a scheme φ' as follows:

$$\varphi' = \{(A_1,x_1),(A_2,x_2),\cdots,(A_{q-1},x_{q-1}),(A_q,x-\sum_{k=0}^{q-1} x_k)\} \tag{4}$$

where q is a subscript which makes

$$\sum_{k=0}^{q-1} x_k < x \leqslant \sum_{k=0}^{q} x_k \tag{5}$$

As $\sum_{k=1}^{n} x_k\geqslant x$, there definitely exists a subscript q ($0<q\leqslant n$) such that (5) holds. Here we make an assumption. Let $R(\varphi',t)$ denote the total reached quantity from s to t according to φ'. We consider two cases. If $t\in[t_q,f]$, then $R(\varphi',t)=x\geqslant(t-s).v$; if $t\in[s,t_q)$, when $t_{k-1}\leqslant t<t_k$, we have $R(\varphi',t)\geqslant R(\varphi',t_{k-1})=\sum_{i=0}^{k-1} x_i\geqslant(t_k-s)v\geqslant(t-s)v$. Therefore, φ' is feasible. □

Theorem 2. The SCS is in a state of emergency, if and only if $\exists k\in\{1,2,\cdots,n\}$

$$\sum_{i=0}^{k-1} x_i < (t_k - s)v \tag{6}$$

Thus, we can determine the state of the SCS according to Theorem 2. As for the SCS depicted in Table 1, we can conclude that it is not in an emergency state. Further, according to the proof process of Theorem 1, we can obtain a feasible scheme φ':

$$\varphi' = \{(A_1,50),(A_2,10),(A_3,100),(A_4,90),(A_5,120),(A_6,30)\}$$

4 The optimal algorithm

From Theorem 1, we can see that if $\Pi\neq\phi$ then there is a feasible scheme $\varphi'(\in\Pi)$. However, the given feasible scheme may include so many suppliers that sometimes it is unpractical. As for example, in an inventory system, the number of involved depots may directly affect the total set up cost. From the point view of reliability or cost, a feasible scheme with fewer depots is preferred[2,4,5]. Let $N(\varphi)$ be the number of suppliers included in φ. Apparently, in this example, $N(\varphi')=6$. When $\Pi\neq\phi$, the optimization problem is

$$\min_{\varphi\in\Pi} N(\varphi) \tag{7}$$

In order to make our optimal algorithm more understandable, we first introduce the process of the algorithm by using the data of Table 1; then we will give mathematical proofs. The corresponding approach in details is as follows.

1) Find all the depots, whose associated lead-time t_i is not bigger than u $(=s=6)$. We have $\{A_1, A_2, A_3\}$, and the corresponding available quantity is $\{50,10,100\}$. Select A_3, because it has the biggest quantity. 2) As $100<x=400$, let $u=6+100/20=11$. Find all the depots except A_3 whose associated lead-time is not bigger than $u(=11)$. We have $\{A_1, A_2, A_4, A_5\}$, and the corresponding available quantity is $\{50,10,90,120\}$. Select A_5, because it has the biggest quantity. 3) As $100+120=220<400$, let $u=11+120/20=22$. Find all the depots except A_3 and A_5, whose associated lead-time is not bigger than $u(=17)$. We have $\{A_1, A_2, A_4, A_6, A_7, A_8\}$, and the corresponding available quantity is $\{50,10,90,90,140,200\}$. Select A_8, because it has the biggest quantity. 4) As $100+120+200=420>400$, let $x_8'=400-(100+120)=180$. Therefore, $\hat{\varphi}=\{(A_3,100),(A_5,120),(A_8,180)\}$

Following the example above, we present an algorithm to solve (7).

Algorithm I ($\Pi\neq\phi$)

1) $u=s, k=1, \text{TOTAL}=0, I_0=\phi$

2) solve i_k: $\max\limits_{i\in\{j|t_j\leqslant u, j\notin I\}} x_i=x_{i_k}, I_k=I_{k-1}+\{i_k\}$

3) if $\text{TOTAL}+x_{i_k}<x$, then $\text{TOTAL}=\text{TOTAL}+x_{i_k}$, $u=u+x_{i_k}/v, k=k+1$, go to 2); otherwise, $x'_{i_k}=x-\text{TOTAL}$

4) $\hat{\varphi}=\{(A_{i_1}, x_{i_1}),(A_{i_2}, x_{i_2}),\cdots,(A_{i_{K-1}}, x_{i_{K-1}}),(A_{i_K}, x'_{i_K})\}$

5 Mathematic proof

Hereinafter, we will give the strict proof of the correctness of Algorithm I. In order to make problems easy to discuss, by slightly modifying Algorithm I, we propose a more generalized algorithm.

Algorithm II($\Pi\neq\phi$)

1) $u=s, d=1, \text{TOTAL}=0, J_0=\phi$

2) $\forall j_d\in\{j\,|\,t_j\leqslant u, j\notin J_{d-1}\}, J_d=J_{d-1}+\{j_d\}$

[Apparently, $\{j\,|\,t_j\leqslant u, j\notin J_{d-1}\}\neq\phi$, otherwise, let $t=u+\delta$, and δ is a small positive number, and no scheme will make (3) hold. That will result in $\Pi=\phi$]

3) if $\text{TOTAL}+x_{j_d}<x$, then $\text{TOTAL}=\text{TOTAL}+x_{j_d}, u=u+x_{j_d}/v, d=d+1$, go to 2); otherwise, $x'_{j_d}=x-\text{TOTAL}$

4) $\varphi=\{(A_{j_1}, x_{j_1}),(A_{j_2}, x_{j_2}),\cdots,(A_{j_{d-1}}, x_{j_{d-1}}),(A_{j_d}, x'_{j_d})\}$

Let Π' be the set of all possible solutions derived from Algorithm II.

Lemma 1. If $\Pi\neq\phi$, any scheme derived from Algorithm II is feasible. That is $\Pi'\subset\Pi$.

Proof. It can be easily proved by Definition 1.

Because Algorithm I is the special case of Algorithm II, the scheme derived from Algorithm I is also feasible. □

Lemma 2. If $\Pi\neq\phi$, then there is at least a scheme $\varphi, \varphi\in\Pi'$, which is the optimal scheme of (7).

Proof. Suppose $\varphi'=\{(A_{i_1}, x'_{i_1}),(A_{i_2}, x'_{i_2}),\cdots,(A_{i_m}, x'_{i_m})\}$ is the optimal solution of (7) $(0<x'_{i_k}\leqslant x_{i_k}, \sum\limits_{k=1}^{m} x'_{i_k}=x)$. Without loss of generality, suppose $i_1<i_2<\cdots<i_m$. That is, $t_{i_1}\leqslant t_{i_2}\leqslant\cdots\leqslant t_{i_m}$. It is easy to see that, $\sum\limits_{k=1}^{m-1} x_{i_k}<\sum\limits_{k=1}^{m} x'_{i_k}=x\leqslant\sum\limits_{k=1}^{m} x_{i_k}$, (Otherwise, $\sum\limits_{k=1}^{m-1} x_{i_k}\geqslant\sum\limits_{k=1}^{m} x'_{i_k}$. It will make contradiction with the fact that φ' is the optimal solution of (7)).

Considering the scheme φ'', $\varphi''=\{(A_{i_1}, x_{i_1}),(A_{i_2}, x_{i_2}),\cdots,(A_{i_{m-1}}, x_{i_{m-1}}),(A_{i_m}, \hat{x}_{i_m})\}$, $\hat{x}_{i_m}=x-\sum\limits_{k=1}^{m-1} x_{i_k}>0$. Apparently, $\varphi''\in\Pi'$. Therefore, like φ', φ'' is also the optimal solution of (7). □

Theorem 3. If $\{(A_{i_1}, x_{i_1}), (A_{i_2}, x_{i_2}), \cdots, (A_{i_{k-1}}, x_{i_{k-1}}), (A_{i_k}, x'_{i_k})\}$ is a scheme deriving from Algorithm I, and $\{(A_{j_1}, x_{j_1}), (A_{j_2}, x_{j_2}), \cdots, (A_{j_{d-1}}, x_{j_{d-1}}), (A_{j_d}, x'_{j_d})\}$ is a scheme deriving from Algorithm II ($\Pi \neq \phi$), then $k \leqslant d$.

Proof. When $d=1$, we have $k=1$, the theorem is proved. In the following discussion, we assume $d \geqslant 2$(Reduction to absurdity)

If $k>d$, then $\sum_{m=1}^{d} x_{i_m} < x = \sum_{m=1}^{d-1} x_{j_m} + x'_{j_d} \leqslant \sum_{m=1}^{d} x_{j_m}$ That is,

$$\sum_{m=1}^{d} x_{i_m} < \sum_{m=1}^{d} x_{j_m} \tag{8}$$

We will obtain a result contradictive to (8). Consider two sequences $x_{i_1}, x_{i_2}, \cdots, x_{i_d}$ and $x_{j_1}, x_{j_2}, \cdots, x_{j_d}$. Because (8) holds, It is easy to see that there is at least one element in $x_{i_1}, x_{i_2}, \cdots, x_{i_d}$, which is smaller than the corresponding element of $x_{j_1}, x_{j_2}, \cdots, x_{j_d}$. Let h denote the position of the first element such that we have

$$\begin{aligned} x_{i_1} &\geqslant x_{j_1} \\ x_{i_2} &\geqslant x_{j_2} \\ &\cdots \\ x_{i_{h-1}} &\geqslant x_{j_{h-1}} \\ x_{i_h} &< x_{j_h} \end{aligned} \tag{9}$$

First consider the two sequences $x_{i_1}, x_{i_2}, \cdots, x_{i_h}$ and $x_{j_1}, x_{j_2}, \cdots, x_{j_h}$. Our thought is to adjust the order of $x_{j_1}, x_{j_2}, \cdots, x_{j_h}$, and try to make every element of $x_{i_1}, x_{i_2}, \cdots, x_{i_h}$ no bigger than the corresponding element of $x_{j_1}, x_{j_2}, \cdots, x_{j_h}$. We hope that by ordering $x_{j_1}, x_{j_2}, \cdots, x_{j_h}$ q times, we have the sequence $x_{j_1^{(q)}}, x_{j_2^{(q)}}, \cdots, x_{j_h^{(q)}}$, and $x_{i_m} \geqslant x_{j_m^{(q)}}$ holds, $m=1,2,\cdots,h$. If this can be done, the theorem is proved. In order to proof it, let us first retrospect the process of obtaining x_{i_h} according to Algorithm I:

$x_{i_h} = \max\limits_{i \in \{j \mid t_j \leqslant u', j \notin I_{h-1}\}} x_i$, $I_{h-1} = \{i_1, i_2, \cdots, i_{h-1}\}$, $u' = s + \sum_{m=1}^{h-1} x_{i_m}/v$. According to Algorithm II, $j_h \in \{j \mid t_j \leqslant u'', j \notin J_{h-1}\}$, $J_{h-1} = \{j_1, j_2, \cdots, j_{h-1}\}$, $u'' = s + \sum_{m=1}^{h-1} x_{j_m}/v$. Three cases are considered:

A) From (9), we conclude $u' \geqslant u''$. Further, follows that, $j_h \in I_{h-1}$ (Otherwise, if $j_h \notin I_{h-1}$, then $j_h \in \{j \mid t_j \leqslant u'', j \notin J_{h-1} \cup I_{h-1}\} \subset \{j \mid t_j \leqslant u', j \notin I_{h-1}\}$. Therefore, $x_{j_h} \leqslant x_{i_h}$. This makes contradiction with (9))

As $j_h \in I_{h-1}$, let $j_h = i_c$, $1 \leqslant c < h$. Adjust the order of $j_1, \cdots, j_c, \cdots, j_h$, and we have the sequence $j_1^{(1)}, \cdots, j_c^{(1)}, \cdots, j_h^{(1)}$, $j_c^{(1)} = j_h, j_h^{(1)} = j_c, j_m^{(1)} = j_m (m \neq c, h)$. Apparently, $x_{i_m} \geqslant x_{j_m^{(1)}}$, $m=1,2,\cdots,h-1$(If $m=c$, then '=' holds).

B) If $x_{i_h} < x_{j_h^{(1)}}$, then $j_h^{(1)} \in I_{h-1}$. As $j_h \in I_{h-1}$, let $j_h^{(1)} = i_e$, $1 \leqslant e < h$. Adjusting the order of $j_1^{(1)}, \cdots, j_e^{(1)}, \cdots, j_h^{(1)}$, we have, $j_1^{(2)}, \cdots, j_e^{(2)}, \cdots, j_h^{(2)}$, $j_e^{(2)} = j_h^{(1)}$, $j_h^{(2)} = j_e^{(1)}, j_m^{(2)} = j_m^{(1)}$ $(m \neq e, h)$. Therefore, the sequence $x_{j_1^{(1)}}, x_{j_2^{(1)}}, \cdots, x_{j_h^{(1)}}$ becomes $x_{j_1^{(2)}}, x_{j_2^{(2)}}, \cdots, x_{j_h^{(2)}}$. Apparently, $x_{i_m} \geqslant x_{j_m^{(2)}}$, $m=1,2,\cdots,h-1$.

C) If $x_{i_h} < x_{j_h^{(2)}}$, then we repeat the process. No more than $h-1$ times will we elicit $x_{i_h} \geqslant x_{j_h^{(h-1)}}$. That is because when the subscript sequence is adjusted $h-1$ times, we have $\{j_1^{(h-1)}, j_2^{(h-1)}, \cdots, j_{h-1}^{(h-1)}\} = \{i_1, i_2, \cdots, i_{h-1}\} = I_{h-1} = J_{h-1}$. It is easy to see that $j_h^{(h-1)} \neq j_1^{(h-1)}, \cdots, j_h^{(h-1)} \neq j_{h-1}^{(h-1)}$. That is $j_h^{(h-1)} \in \{j \mid t_j \leqslant u', j \notin J_{h-1} = I_{h-1}\}$. Therefore, $x_{i_h} \geqslant x_{j_h^{(h-1)}}$. That is to say, by adjusting the order q times ($q<h$), we elicit the sequence $x_{j_1^{(q)}}$, $x_{j_2^{(q)}}, \cdots, x_{j_h^{(q)}}$, and $x_{i_m} \geqslant x_{j_m^{(q)}}$, $m=1,2,\cdots,h$.

By the same token, the order of $x_{j_1}, x_{j_2}, \cdots, x_{j_d}$ can be adjusted so that no element of this sequence will be bigger than the corresponding element of $x_{i_1}, x_{i_2}, \cdots, x_{i_d}$. When this is done, we will have elicited the result contradictive to (8). The theorem has been proved. □

Theorem 4. The solution deriving from Algorithm I is the optimal solution of (7)

According to Lemma 1, Lemma 2 and Theorem 3, it is easily proved.

6 Conclusion

This paper shows that there exists an efficient method to identify the state of the SCS (Theorem 2). When the system is not in a state of emergency, this paper gives an optimal algorithm (Algorithm I), and the corresponding mathematical proof is presented. However, a very important problem, which this paper does not discuss, is that when an SCS is in the emergency state, how can we deal with it? This may require some specific emergency methods and techniques that need further research. As we know, [3] discussed a scheme with discrete demand. This paper, however, considers the continuous demand. Future research may focus on a general demand function that is more representative.

References

1 Dayani Sedarage, Okitsugu Fujiwara, Huynh Trung Luong. Determining optimal order splitting and reorder level for N-supplier inventory systems. *European Journal of Operational Research*, 1999, **116**(5):389～404

2 Liu Chun-Lin. Models and approaches for the material dispatch problem in emergency management[Ph. D. dissertation]. Nanjing: Southeast University, 2000 (in Chinese)

3 Liu Chun-Lin, He Jian-Min, Shi Jian-Jun. Study of collaboration-supply in a supply chain. *Journal of Management Sciences in China*, 2002, **5** (2):29～33 (in Chinese)

4 Liu Chun-Lin, Sheng Zhao-Han, He Jian-Min. Multi-depot selection in emergency systems based on continuous consumption. *Journal of Industrial Engineering and Engineering Management*, 1999, **13** (3):13～16(in Chinese)

5 Michael O Ball, Feng L Lin. A reliability model applied to emergency service vehicle location. *Operations Research*, 1993, **41**(1):18～23

6 George F List. Routing and emergency-response-team siting for high-level radioactive waste shipments. *IEEE Transactions on Engineering Management*, 1998, **45**(2): 141～152

7 Liu Chun-Lin, He Jian-Min, Sheng Zhao-Han. Selecting of the maximum satisfaction factor path in fuzzy emergency network systems. *Acta Automatica Sinica*, 2000, **26**(5): (in Chinese)

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连续需求条件下供应链紧急状态识别与优化方案求解

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摘 要 研究连续需求条件下企业供应链系统的紧急状态识别和最优调度方案求解问题.在一个协作的供应链网络中,企业的原料物资常常会由多个供应商(供应点)提供,当这些供应商无法完全满足企业物资需求时,供应链系统处于紧急状态.本文研究表明,存在一种有效方法判定供应链系统是否处于紧急状态;并且当系统处于非紧急状态时,给出了最优方案的求解算法,并对该算法给予相应数学证明.

关键词 供应链,连续需求,供应商,紧急

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