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An Advanced ATP Decision Support System in Stockout Situations

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Abstract: Order management is a major component of the order fulfillment process (OFP). The aim of this activity consists in maximizing the responsiveness, flexibility and efficiency of a customer order fulfilment. But what happens in case of shortage? Today, no particular method seems to allow managing bulk orders properly. In situations of stockout, the different actors involved in the OFP may have difficulties in deciding the best responsive solution that would preserve customer satisfaction. The aim of this paper is to achieve this goal by developing a multi-criteria decision support system, based on the Advanced Available-to-promise (AATP) technique.

1. INTRODUCTION

Walters and Rainbird (2004) argue that a firm is best placed to create value and exploit market opportunities when there is an effective combination of Supply Chain (SC) capabilities (efficiency) and Demand Chain (DC) effectiveness to maximise the organisation's overall value chain. This is the role of the order management (OM) activity, which is one of the key components of the order fulfilment process (OFP). An OFP involves generating, filling, delivering and servicing customer orders (Croxton, 2003). The OFP is complex because it is composed of several activities, executed by different functional entities, and heavily interdependent among the tasks, resources and agents involved in the process (Lin and Shaw, 1998). It is difficult to manage because each entity, which intervenes in the process, has its own objectives. Croxton et al. (2001) note that effective OFP requires integration of the firm's manufacturing, logistics and marketing plans. Within the OFP, the aim of the OM activity is to receive orders from customers and to commit order requests. In other words, OM consists of analysing orders and managing backlog in order to determine if, how and when orders can be delivered. Its main objectives can be summarized into two dimensions (Lin and Shaw, 1998):

- delivering qualified products to fulfil customer orders at the right time and right place;
- achieving agility to handle uncertainties from internal or external environments.

In practice, there are techniques that enable the OM activity to partly achieve these goals by choosing between different alternatives. These techniques are: available-to-promise (ATP), advanced available-to-promise (AATP), capable-to-promise (CTP), and profitable-to-promise (PTP). However, in case of stockout, they are insufficient for decision making in the face of certain variables such as: unknown availability, product substitution and specific operations. Based on this, our first problem statement is: *PS1: How can promised customer orders be fulfilled in case of stockout?*

Moreover, even though the OFP has a clear global objective to provide to the customer the right product, at the right price and at the right time, each functional entity that participates in this process tries to achieve their own individual objectives. These objectives are generally contradictory. For example, in case of stock-out:

- Distribution would want to delay and deliver in one batch all the products of an order, in order to minimise the costs of transportation.
- Sales department would want to maximise the turnover of the current month by sending backorders separately.
- Marketing would not want to sell some products separately. For example, in the cosmetic industry, an order with a solar cream and a booklet cannot be delivered if one of the two articles is not available.
- Manufacturing would want to minimise the impact of the stockout on its schedule (and probably also on its costs) by not changing the schedule in order to quickly produce the item out of stock.
- The Customer wants to be served as promised.

Thus, our second problem statement can be formulated as: *PS2: How should the contradictory objectives of the different functional entities (agents) be taken into consideration in the order management activity?*

This paper suggests an approach that tackles the above two problem statements (PS1 and PS2) in the order fulfilment decision-making process.

2. LITERATURE REVIEW: AVAILABLE-TO-PROMISE METHODS

As mentioned earlier, there are several techniques that support the OFP and more precisely the OM activity. The

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most commonly used is probably ATP (available-to-promise). According to APICS (2005), ATP is the uncommitted portion of a company's inventory and planned production maintained in the master schedule to support customer order promising. This promising mechanism is suitable for make-to-stock (MTS) production systems. Actually, in the MTS model, finished goods are produced according to demand forecast and put into inventory before an order is received from a customer. In the make-to-order (MTO) strategy, to avoid "over promising" and "under promising" on job orders, delivery dates have to be set based on available capacity and material constraints. Techniques used to achieve this goal are referred to as capable-to-promise (CTP), and they help to determine whether customers' requested delivery dates can be met (or at least, to determine the earliest realistic date a product can be promised). ATP and CTP are searched along three dimensions (Kilger and Schneeweiss, 2000): time, customer and product. In case of shortage, different rules can be envisaged to manage the ATP/CTP along these three dimensions. As an example, customers' allocation might be done through: ranked based, fixed split, First-Come-First-Served or per committed (quotas). A third technique used to determine the delivery date is profitable-to-promise (PTP). This method is used in manufacturing systems which have a big product mix and many kinds of customers (Ashfaque, 2005). In this case, individual orders are prioritised based on margins, preferred customers, preferred orders or any other criteria that affect the bottom line. A PTP analysis allows the business to find out if a particular order will be profitable to make, considering the raw material costs, process costs, inventory costs and other costs against the price the customer is willing to pay. The PTP technique works well for all industries, be it discrete, process, mill or flow manufacturing. In the case of MTS companies, PTP works on the data from distribution planning. In the case of MTO companies, PTP works on the data from production planning. In summary, profitability is the only criterion considered by the company.

Note that if no promise can be found for an order, the SC will not be able to fulfil the order within the allocation planning horizon (Kilger and Schneeweiss, 2000). But orders have to be fulfilled nevertheless! Today, no ATP method enables to manage bulk orders to deliver them more responsively. Some authors have proposed to develop the advanced available-to-promise (AATP) in order to enhance the responsiveness of order promising and the reliability of order fulfilment (Pibernik, 2005). AATP directly links available resources (i.e. finished goods and work-in-progress) as well as raw materials, production and distribution capacity with customer orders in order to improve the overall performance of the SC/DC. While ATP consists of simply monitoring the uncommitted portion of current and future available finished goods, AATP provides a decision-making mechanism for allocating available finished goods inventory to customer orders and concluding order quantities and due date quotes. The characteristics used for classifying AATP are (Pibernik, 2005):

- The availability level: finished goods inventory or supply chain resources (including raw materials, work-in-progress, finished goods…);
- The operating mode: real time or batch mode;
- The interaction with manufacturing resource planning: active (AATP modifies the Master Schedule) or passive (AATP is done independently with information regarding finished goods and resource availability).

Some additional advanced ATP functionalities are currently discussed by researchers (Kilger and Schneeweiss, 2000; Pibernik, 2005). These functionalities mainly refer to strategies applied to an anticipated shortage of finished goods or supply chain resources. Siala et al. (2006) summarise them in a fourth dimension which is the flexibility of the solution proposed to the customer. Three different strategies can be supported by AATP (Pibernik, 2005):

- AATP with substitute products: in certain cases substitute products can be delivered within the given delivery time window in place of the product originally ordered by the customer.
- Multi-location AATP: if the customer order cannot be fulfilled with the finished goods or supply chain resources at a given location, available finished goods and resources can be sourced at other locations.
- AATP with partial delivery: if the ordered quantity is not available within the given delivery time window, the customer order can be fulfilled with two or more partial deliveries.

These different strategies can be combined in any possible sequence in the AATP planning mechanism (Pibernik, 2005). Besides generating these strategies sequentially, they can be combined in the AATP planning mechanism in such a way that all feasible solutions are determined and assessed simultaneously. This provides a partial answer to problem statement 1, presented in section 1. But, no research work seems to have developed rules for identifying and assessing alternative strategies in case of a temporary shortage of finished goods (Pibernik, 2005). It becomes clear that models and algorithms generating order quantity and due date quotes, based on pertinent information concerning customer orders, uncommitted finished goods quantities as well as customer priority and preference, represent the core of AATP planning mechanism (Pibernik, 2005). Though some authors such as Pibernik (2005) and Siala et al. (2006) have tried to consider these strategies in their AATP planning mechanism, none seems to have studied the impact of the different functional entities involved in the OFP (see problem statement 2). Practically, these contributions consider a single stakeholder's point of view, that of the customer (Pibernik, 2005) or that of the Decision Centre (Siala et al., 2006).

3. PROPOSITION: MULTI-CRITERIA ADVANCED ATP DECISION SUPPORT SYSTEM

3.1 Multi-Criteria Advanced ATP Overview

While Siala et al. (2006) have proposed a planning mechanism for a multi-location real-time AATP based on finished goods inventory and substitute products, we propose to analyse multi-items orders through a multi-location batch-time AATP based on finished goods inventory, substitute products and partial delivery within a non sequential mode. In a nutshell, the aim of this research is to present a multi-criteria approach to manage bulk orders by developing a specific AATP that:

- analyses in a batch mode orders that are composed of several items;
- studies partial delivery, substitute product, delayed delivery and alternative location possibilities;
- allows comparing all the order strategies by considering criteria and constraints of the different actors that are involved in the order fulfilment process (non-sequential mode), thereby integrating the overall chain from both demand and supply perspectives.

The mechanism developed in our model (Figure 1) is triggered by the arrival of a customer order:

1. The allocation (commitment) is checked. Allocations are calculated from forecasts and relate to the quantities committed to the customer. When there is no allocation defined, the order should not be fulfilled. But in some cases, the order could be fulfilled if there are overstocks.

2. When the line refers to a commitment (quote), stock availability for all items of the order (original and potential substitutes) within the time window is checked on all sourcing locations (usual and alternative).

3. In the event of a shortage for an item, the AATP looks for alternative strategies to serve the customer responsively. Consequently, the customer's requirements must be known:

- the maximum number of shipments that can be accepted;
- the authorization to split a line of the order (i.e. the possibility to deliver an order line in several times);
- the maximum delay that can be considered;
- the possibility to substitute some items of the order.

4. In case of stockout, the problem turns into satisfying the customer order as well as possible according to the contradictory objectives of the different stakeholders: Distribution, Sales, Marketing, Manufacturing, and of course, Customer. This step consists therefore in defining several strategies corresponding to different governance policies. For instance, if we want to support the supplier objectives, then it could be useful to consider the distribution costs (order preparation and transportation) as more important than the costs of delay. This step produces a set of strategies, depicted through a set of parameters (coefficients) that will permit to translate each policy in the AATP model (see sections 3.2 and 3.3).

5. By using our multi-criteria AATP model that is developed in the sections below, an optimization is run. Because the aim is to reach a judicious compromise between the SC and DC points of view, this step establishes for each strategy previously designed, the best solution regarding to the objective function of the model. This function is based on a multi-criteria approach that considers the criteria of all the actors that are involved in the OFP.

6. This assessment then determines a list of good solutions that could be proposed to execute the OM Activity. Taking into consideration actual operational parameters, the decision maker has to select the most responsive solution.

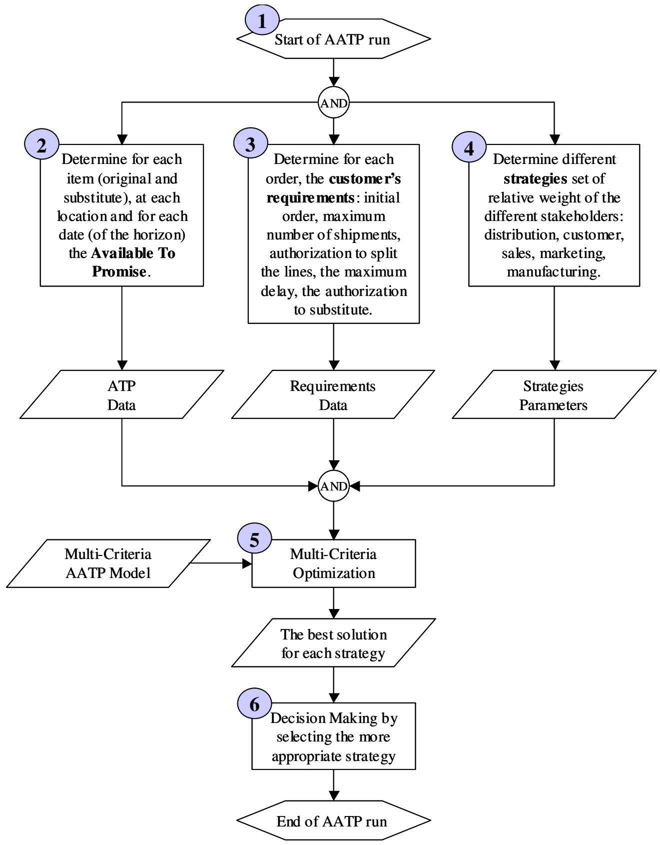

Fig. 1. Multi-criteria AATP

3.2 *Multi-Criteria Assessment Hypothesis*

This part describes the hypothesis of the model and the associated symbols that we use in our model. The first hypothesis considers that an order is composed of n different lines (multi-references order). Each line can be defined by a product (item) p and a quantity D_p. The product p is positioned on the line p. The customer wants to be delivered at a Due Date, DD. There is a delay as soon as the effective delivery date is beyond the DD. The latest delivery date authorized by the customer is referred to as the Dead Line, DL. Beyond this DL, the customer will refuse the backorder. There is a cost due to the shortage, CSh_p.

A delay cost is considered, CDV_p. This cost depends on the laps of time between DD and the effective delivery date, as well as on the quantity delivered late. We also consider a fixed cost as a delay penalty, CDF. An order can be delivered in several times. $Nshipmax$ defines the maximum number of shipments for an order. We consider that there are two shipments as soon as:

- an order is delivered from 2 sourcing sites s;
- an order is prepared from a sole sourcing but at two different dates.

One shipment from a sourcing site *s* implies a preparation cost (*CP*) that includes a fixed part CPF_s depending on the sourcing site and a variable part CPV_{ps} depending also on the sourcing site and the quantity of product *p* picked. Moreover, a transportation cost must be considered. This cost is defined through a variable cost CTV_{psc} that depends on the quantity delivered and the distance between the sourcing site *s* and the customer *c*. An order line *p* can be delivered in several times. $Nsplitmax_p$ defines the maximum number of splits authorized by the customer, for a given line. We consider that a line is split when the overall quantity of the line is delivered in at least two shipments. Therefore, two different cases must be considered: the total quantity is shipped from a sole source at different dates or the total quantity is shipped from different sources. No particular cost has been associated to this in order not to penalize the supplier twice. Actually, if the line has been split then the order shall be delivered late (including a delay cost) or delivered from different sources (including an increase in the transportation cost). In this study, we have envisaged the possibility to substitute the missing item. Consequently, the original product *p* can be substituted by a set of products S_p. The cost of substitution depends only on the quantity of the substituted product QS_p. We note that all products (original or substitution) can be delivered from different sources *s*.

3.3 Multi-Criteria Assessment Model

The following elements describe our AATP model concerning a single order treatment. We consider the following suffixes:

- p denotes the product (item); p = 1...n, where n is the total number of lines in the order;
- r denotes the substitute product (replacement product) index;
- q denotes all product (ordered and substitute) index;
- s denotes the source (distribution centre); s = 1...S, where S is the number of different sources;
- t denotes the time periods; t = 1 ..T, where T is the planning horizon

Let us describe the data of the model:

S_p: The set of substitute products with respect to p.
D_p: Demand of product p in a given order.
ATP_{qst}: Number of products q available on site s on date t.
Nshipmax: Maximum number of allowed shipment.
$Nsplitmax_p$: Maximum number of allowed split for a line p
DD: Due Date.
DL: Dead Line.
T: Planning horizon.
CPF_s: Fixed preparation cost for a site s.
CPV_{qs}: Preparation cost for an item q on a site s.
CTV_{qsc}: Transportation cost of an item q from a site s to a customer c.
CDF: Fixed penalty if there is at least one period delay within the order delivering time window (for DD<t<DL).
CDV_p: Cost of delay for one period for the product p (for DD<t<DL).
CSV_p: Cost of substitution for a product p.
CSh_p: Cost of shortage for a product p.

The variables of the model are:

X_{pst}: Number of product p picked on the site s on date t.
XC_{pst}: Total quantity of product p picked on site s and delivered on date t.
XR_{rst}: Quantity of substitute product r picked on site s and delivered on date t.
XRC_{pst}: Total quantity of substitute product r picked on site s and delivered on date t.
Y_{ipst} ($i \in$ Sp): Number of product i substituted to p picked on the site s on date t.
Q_{pt}: Quantity of product picked on date t to satisfy line p (product p or substitute).
QS_p: Quantity of product p substituted.
$Shortage_p$: Backorder quantity for a product p.
OD: Variable linked to the Due Date (Order Delay = {0,1}).
OD = 1 if there is delay (i.e. DD<t< DL), 0 otherwise.
DCU_{st}: Variable linked to the use of the source s on date t (Distribution Center Using) DCUs = {0,1}.
DCU_{st} = 1 if the site s is used on date t, 0 otherwise.
R_{pst}: Quantity of product picked on date t from the site s to satisfy the line p (product p or substitute).
OR_{pst}: Boolean variable linked to the quantity of product picked on date t from the site s to satisfy the line p.
SUB_p: Variable linked to the substitution SUBp = {0,1}.
SUB_p = 1 if the product p is substituted, 0 otherwise.

Finally, the objective function (1) tries to minimize the total cost of the system (preparation costs *CP*, transportation costs *CT*, delay costs *CD,* substitution costs *CS* and shortage costs *CSh*). However the objective function has to be representative of our Problem Statement 2. Thus, we propose to balance the different costs of the system in order to be able to reflect the strategy of the network. Consequently, if the network supports mainly the SC point of view (and so, the efficiency) then the preparation and transportation costs will get an important weight. Otherwise, if the network wants to focus on the DC point of view (and so, the effectiveness) then the substitution costs and delay costs will be more important. The aim is to minimize the total cost:

$$\text{Min } [w(CP) * CP + w(CT) * CT + w(CD) * CD + w(CS) * CS + w(CSh) * CSh] \quad (1.)$$

where *w* is the balancing coefficient for a cost.

The different costs are defined below.

Order Preparation Cost (CP):

$$CP = \sum_{s} (\sum_{t} DCU_{st}) * CPF_s + \sum_{p} \sum_{s} [\sum_{t} (X_{pst} + \sum_{i \in Sp} Y_{ipst})] * CPV_{ps} \quad (2.)$$

Transportation Cost (CT):

$$CT = \sum_{p} \sum_{s} [(\sum_{t} (X_{pst} + \sum_{i \in Sp} Y_{ipst})] * CTV_{psc} \quad (3.)$$

Delay Cost (CD):

$$CD = OD * CDF + \sum_{t>DD} \sum_{p} Q_{pt} * CDV_p * (t-DD)$$

$$\text{for } DD \le t \le DL \quad (4.)$$

Substitution Cost (CS):

$$CS = \sum_{p} QS_p * CSV_p \qquad (5.)$$

Shortage Cost (CSh):

$$CSh = \sum_{p} Shortage_p * CSh_p \qquad (6.)$$

The equations (7) to (23) express the constraints of our ATTP model according to the approach presented in 3.1 and 3.2.The sum of the different cost balancing coefficients must be equal to 1:

$$w(CP) + w(CT) + w(CD) + w(CS) + w(CSh) = 1 \qquad (7.)$$

The quantity of product *p* picked at *t* (t < DL) must be equal to the total of *p* picked on all sourcing sites *s* at *t* and to the total of products *i* ($i \in Sp$) substituted to *p*.

$$Q_{pt} = \sum_{s} X_{pst} + \sum_{s} \sum_{i \in Sp} Y_{ipst} \quad \text{for } t < DL \qquad (8.)$$

The customer does not allow any deliveries after the date DL:

$$Q_{pt} = 0 \text{ if } t > DL \qquad (9.)$$

In order to be able to calculate the preparation and transportation costs, we have to determine the quantity of product *p* picked on each sourcing site *s* at each date *t* (10):

$$R_{pst} = X_{pst} + \sum_{i \in Sp} Y_{ipst} \quad \text{for } t < DL \qquad (10.)$$

The total quantity of product p delivered from a given source *s* at date *t* must be lower than or equal to the quantity available at this source s at the shipment date (*t – DLs*):

$$XC_{pst} = \sum_{i=1,t} X_{psi} \qquad (11.)$$

$$XC_{pst} \leq ATP_{pst-DLs} \quad \text{for } t > DL_s \qquad (12.)$$

The quantity of product *p* delivered from a given source *s* at a given date *t* is equal to 0 if the date *t* is lower than or equal to the delivery time from the site *s*:

$$Xpst = 0 \quad \text{for } t \leq DL_s \qquad (13.)$$

There are similar constraints for substitute products:

$$XR_{rst} = \sum_{i \in Rr} Y_{ipst} \qquad (14.)$$

$$XRC_{rst} = \sum_{i=1,t} XR_{rsi} \qquad (15.)$$

$$XRC_{rst} \leq ATP_{rst-DLs} \quad \text{for } t > DL_s \qquad (16.)$$

$$XR_{rst} = 0 \quad \text{for } t \leq DL_s \qquad (17.)$$

Within the whole time window, the quantity of product *p* substituted is equal to the sum of the quantity of product *r* substituted to *p*::

$$QS_p = \sum_{r \in Sp} \sum_{s} \sum_{t} Y_{rpst} \qquad (18.)$$

The shortage is equal to the total quantity ordered minus the total quantity delivered at date DL:

$$QP_{pDL} + Shortage_p = D_p, \quad \forall p \qquad (19.)$$

For a given order, a sourcing site must be used less than the maximum number of shipments acceptable for the order:

$$Nshipmax \geq \sum_{s} \sum_{t} DCU_{st} \qquad (20.)$$

Each time a sourcing site is used ($DCU_s = 1$), the quantity of product *p* delivered is limited by the total demand of *p* (for each product and each distribution centre). Thus if $DCU_s = 0$ (an unused source *s*), then $Q_{pt} = 0$.

$$\sum_{p} X_{pst} + \sum_{p} \sum_{i \in Sp} Y_{ipst} \leq D_p * DCU_{st} \qquad (21.)$$

The number of pickings to fill a given order line *p* is limited by the maximum number of splits acceptable by the customer. Because 1 split implies 2 shipments, we have to consider $OR_{pst} - 1$:

$$Nsplitmax_p \geq \sum_{s} \sum_{t} OR_{pst} - 1 \qquad (22.)$$

For each substitution ($SUB_p = 1$), the quantity of product *p* delivered must be inferior to the total demand of *p* (valid for each product). If $SUB_p = 0$, then $QS_p = 0$.

$$QS_p \leq D_p * SUB_p \qquad (23.)$$

4. NUMERICAL APPLICATION

In this section, we implement our model on a numerical example. We consider an order placed by a customer at t=0. This order includes three different products: 70 units of item M, 50 units of item N and 40 units of item O. In week 1, there is a shortage of all these items. The customer does not want to receive his order in more than three times and the order line of item M cannot be split more than once. The latest delivery date acceptable by the customer is week 5. The supplier gets 2 distribution centres and items M and N can be substituted. The main data of this problem are depicted in Table 1.

	M		M'		N		N'		O	
Period	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
1	20	0	5	10	30	10	5	0	20	0
2	20	5	5	10	30	10	5	0	20	0
3	25	5	5	20	30	10	10	0	40	0
4	25	10	10	20	30	10	10	5	40	0
5	30	10	10	20	40	10	10	5	40	0
	M		**M'**		**N**		**N'**		**O**	
Cost	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
CPFs	15	15	15	15	15	15	15	15	15	15
CPVps	2	4	2	3	3	5	2	3	2,5	4
CTVps	2	4	2	3	3	5	2	3	2,5	4
CDF	60	60	60	60	60	60	60	60	60	60
CDVp	3	3	3	3	5	5	5	5	3	3
CSVp	3	3			10	10				
CShp	40	40	40	40	20	20	20	20	35	35

Tab. 1. Numerical Data

Due to the restrictive length of this paper, we present here the analysis of only three extreme strategies (Table 2):

1. All the cost coefficients have the same weight (i.e. DC and SC points of view are equivalent);

2. The DC point of view is more important than the SC point of view. The shortage has been accentuated while the

delay coefficient has been decreased (the objective is to deliver the order completely even if there is a delay);

3. The SC point of view has been supported by considering stronger preparation and transportation coefficients.

Table 3 shows the results (using ILOG OPL software). For each strategy, the different costs, the total cost, the number of shipments (including the weeks) and the number of items that could not have been delivered, is presented.

	w(CT)	w(CP)	w(CS)	w(CD)	w(CSh)
Pb1	0,2	0,2	0,2	0,2	0,2
Pb2	0,2	0,2	0,2	0,1	0,3
Pb3	0,4	0,3	0,1	0,1	0,1

Tab. 2. Numerical Parameters

The optimal solution (minimal cost) is obtained within strategy 1. The customer will receive his order in three times and 20 units will be missing. In strategy 2, we wanted to support the DC point of view by guaranteeing a complete fulfilment of the order. Although the delay cost is very high, the customer will receive the totality of his order in 5 weeks. This solution gives the highest total cost. With the last strategy, we can see that the preparation and transportation costs are low. This corresponds to our wish to give preference, in this case, to the SC point of view. However, the customer will not be penalized in terms of deadline (delay cost is lower than in the two other cases). But there is a lack of 25 units!

	CT	CP	CS	CD	CSh	Z*	Nbship	Date ship	Shortage
Pb1	370	45	140	660	500	1715	3	1,3,4	20
Pb2	445	45	140	1300	0	1930	3	1,4,5	0
Pb3	350	45	140	540	700	1775	3	1,3	25

Tab. 3. Results of the Case Study

Even though the first strategy produces the least expensive solution, the OM decision maker may choose to execute the second solution, especially if we consider the customer as important, and would want to make him more loyal. In reality, the second strategy enables us to deliver the order completely although the cost is higher. The third strategy does not seem an interesting solution. However, such a strategy should be relevant in some particular cases (if transportation is very expensive for instance). Finally, this application brings to light the advantages, in case of stockout, of comparing different strategies in order to fulfil customer orders as responsively as possible.

5. CONCLUSION AND FUTURE WORK

Usually, when there is a shortage, OM decision makers have problems in determining satisfactory solutions to deliver orders given the disparate objectives of the different stakeholders of the value chain. Our work aims to help them by providing an ATTP decision support system. Compared to traditional AATP mechanisms, our proposition enables to clearly strike a balance between the SC and DC points of view, in order to make a responsive decision. With the traditional sequencing AATP, OM decision makers execute the first solution that is feasible (according to the pre-determined sequence). This solution represents one and only one point of view (SC or DC). Other solutions could exist and should have been studied. Our model enables to design for different governance strategies and different "good" solutions. Each strategy corresponds to a particular balance of the contradictory objectives of the value chain. All the solutions can therefore be compared in order to select the most effective with regards to operational constraints. Three main perspectives arise from this study:

- The first one consists of validating the robustness of our model. A comparative test with a traditional AATP is in progress on a real healthcare SC. The first experiments show that the model allows to solve a more complicated numerical application. In this work, more than 2,000 orders (including about 10 products each) are analysed each day. The average running time for each order is about 2 seconds.
- The second one aims to assess the impact of the different weights on the model. Thus, the strategies to determine the relevant weights shall be considered.
- The third one will try to develop a structured methodology to help OM decision makers to define their strategies. This work will permit to discuss, regarding to different settings, the different possibilities to manage the stock-out situation.

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