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# MRP-based negotiation in customer-supplier relationship

Yue Ming, Raymond Houé, Bernard Grabot

University of Toulouse, INP-ENIT, 47 Avenue d'Azereix,  
BP1629, F-65016 Tarbes Cedex, France,  
(e-mail: {yue.ming, raymond.houe, bernard.grabot}@enit.fr)

**Abstract:** In the present uncertain context, increasing the performance of the supply chains requires to define cooperative processes between partners aiming at providing a better answer to the final customer, with a risk shared between partners. Based on an analysis of real practices, we suggest in this communication to take the MRP process as a basis for defining what could be such a cooperative process.

**Keywords:** MRP, supply-chain, negotiation, cooperation, planning.

## 1. INTRODUCTION

Since the manufacturing companies are nowadays more and more focusing on their core processes, supply chains become larger and more complex structures which management has motivated a huge literature. Indeed, it is much more difficult to coordinate distant partners, who can have very different size and culture, than workshops belonging to the same plant. The growing uncertainty on the customers' demand makes this coordination still harder, and it is usually considered that an increased cooperation is a good way to mitigate the risks linked to this uncertainty (Hallikaset al., 2005). We suggest in this communication to use the MRP method as a basis for supporting a cooperative process aiming at a better synchronization of the partners, in a context of risk sharing.

A short state of the art on collaborative processes in supply chains is given in section 2, whereas the main findings of a project aiming at analyzing real practices in supply chains of the aeronautic sector are summarized in section 3. In section 4 are described some points on which a negotiation could be of mutual benefit for the partners, within a collaborative process. One of these negotiation processes is described with more details in section 5.

## 2. COLLABORATION IN SUPPLY CHAINS

Coordination, cooperation and collaboration are defined by several authors as increasing degrees of relationships between supply chain partners (see for instance (Camarinha-Matos et al., 2009)). Coordination of supply chain partners, which is the first condition for working together, may be achieved in a centralized or distributed way. In the first case, a dedicated software (Advanced Planning System - APS) is used to gather the information coming from each partner and suggest a planning including both manufacturing and transportation activities (Stadtler et al., 2007). This solution may allow an optimization of the global planning, but is poorly consistent with the autonomy of partners, who are usually independent companies. Therefore, supply chain planning is mainly achieved through local communication between a customer

and his suppliers, as suggested in industrial reference models for supply chain management like SCOR (SCOR, 2008). In that case, planning is achieved using a cascade of MRP2 (Manufacturing Resource Planning) modules (Orlicky et al., 1994), as denoted in Fig. 1, taken from (Grabot et al., 2009): the final assembler collects forecasts, then defines a Sales and Operation Plan, usually referring to groups of products. He then builds a Master Production Schedule by product, and determines which components are required, by running the Material Requirement Planning module. The MRP step results in a production plan, allowing to build an internal load plan, and in a supply plan, sent to the suppliers. This supply plan, including a firm period (in which the orders cannot be modified) and a flexible period (in which changes may arise within given limits), is considered as forecasts by the suppliers.

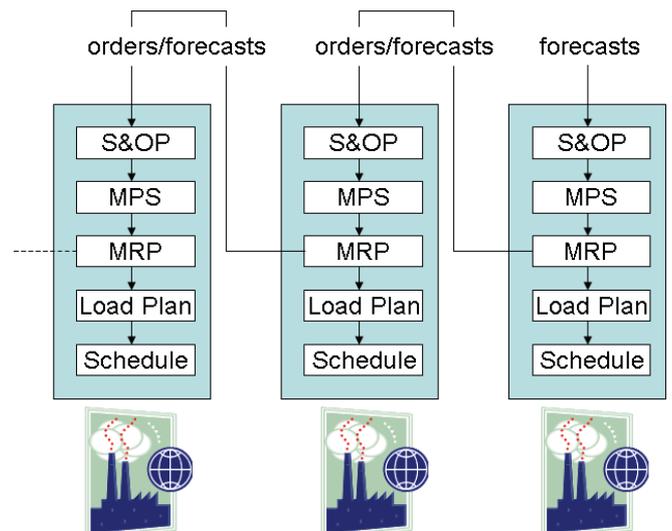


Fig. 1. Supply chain planning using a cascade of MRP processes (Grabot et al., 2009)

Many parameters used in the MRP calculations, like the lead times, production and transportation lot sizes, etc., are defined in the contracts that link customer and supplier.

In order to be more reactive, new ways to collaborate on some specific aspects of the planning process have been defined in the last ten years, like Collaborative Planning, Forecasting and Replenishment (CPFR) (VICS, 2011) or Vendor Managed Inventories (VMI) (Disney et al., 2003). Nevertheless, these methods do not address the whole process described in Fig. 1.

For academics, cooperation in supply chains is often considered as suppliers and buyers becoming strategic partners, sharing risks and benefits, exchanging operating and financial information, making joint investments in facilities and systems, jointly involved in continuous improvement and new product development programs, and making their success interdependent (Albino et al., 2007). Such cooperation is based on a "strategic partnership" sometimes called "cooperative SC relationship" (Ellram, 1991). In such business relationship, cooperation should start with joint planning and end with joint control activities to evaluate the performance of the supply chain members as well as the supply chain as a whole (Cooper et al., 1997; Tyndall et al. 1998). Nevertheless, the reality of nowadays supply chains usually still shows more basic relationships: an intense upstream information flow can be noticed, in order to propagate the final customer's demand through the supply chain (see Fig. 1), but the downstream information flow is usually limited, each supplier having to answer to his local customer's demand by every mean.

We have had the opportunity to analyse the behaviours resulting from such relationship in aeronautical supply chains of the south-west of France. Some findings of the study are summarized in next section.

### 3. CASE STUDIES

During the last few years, we have been involved in several projects aiming at analyzing or improving cooperation in supply chains, among which one performed with funding from an association of companies of the aeronautic sector and from a public body interested in SMEs (Small and Medium Enterprises) development. The objective of the project was to analyze the problems linked to the cooperation between partners of aeronautical supply chains, especially when SMEs were involved. Twenty companies were visited in that purpose: 7 large ones and 13 of middle (around 200 employees) or low (less than 100 employees) size. If the relatively low number of the visited companies does not allow to fully guaranteeing the generality of the identified problems and situations, it is consistent with the results of previous projects on the same domain (Marcotte et al., 2009) and shows that some problems are not yet fully taken into account by present practices.

Many problems linked to the real implementation of the previously described processes were identified during the interviews. We shall not give here an exhaustive list, but focus on some of them, which have influenced the rest of our study.

#### 3.1 Problems linked to the firm period of the forecasts

The first issue identified during the interviews is that the size of the frozen period of the forecasts may be inconsistent with the supply lead times. As an example, a relative scarcity of some aeronautical alloys together with a lack of capacity of companies providing casting parts made that the supply time of some raw materials increased up to 12 months in some cases. In spite of this, the firm period of the forecasts sent by the customers to their suppliers remained constant, around 3 months, compelling the suppliers to take the risk to order materials on the base of flexible forecasts, or to take the risk to be late if they would wait for the corresponding orders to be confirmed.

**Example:** A company manufacturing small (and highly customized) aircrafts has a firm horizon of 12 months, whereas its supply time for the motors is 14 months, the variant of the motor being chosen by the customer.

#### 3.2 Protection or pressure using the periods of the forecasts

Some (rare) companies use the difference between the firm period received from their customers and the one they send to their suppliers as a way to protect their smallest partners, who may have difficulties for dealing with large variation of the demand.

**Example:** A large tier 1 company mentioned that the importance of one his customers obliged him to accept that all orders could be cancelled until reception. However, the company did not set into question the firm horizon sent to his own suppliers, but introduced high flexibility ratios ( $\pm 50\%$ ) in the flexible zone. In order to make this acceptable, they decided that if the ordered quantities decreased too much in this flexible period, they would commit to buy the parts by the end of the current year.

#### 3.3 Load smoothing at supplier's

Load smoothing may be an important issue for SMEs, which have a limited capacity. During the periods when the load is important, some orders may have to be delayed while when the load is low, SMEs are looking for work in order to get minimum incomes.

**Example:** A supplier explained that during a difficult period, he decided to work on orders belonging to the flexible period of the forecasts sent by his customer, even if he was not sure that these orders would be finally confirmed. For him, the risk was limited and the over cost linked to the late payment and increased inventories was lower than the cost required to temporarily decrease his capacity.

#### 3.4 Protection against variations of load

Load smoothing can also be performed by the customer: some cases have been seen where this problem was formally taken into account by customers willing to protect their smallest suppliers.

**Example:** A customer wanted to protect its smallest suppliers

from load variations. As a consequence, a maximum variation between two consecutive periods was considered as a constraint for building his supply plan. The consequence was that the customer had to anticipate any variation and to increase his inventory level in order to cope with the demand of his own customers, varying more dynamically.

### 3.5 Link between price and cycle time

Satisfying urgent orders is part of the daily work in aeronautical supply chains; it usually means to spend extra money (due to extra hours, etc.) or to postpone other orders considered as less urgent, creating perturbations in the planning. In some very specific cases, we have seen that the principle of a negotiation of the price and cycle time was considered in order to address the problem of these urgencies.

**Example:** A company, who has a strong position because of the scarcity of his competence (surface treatment), managed to impose to its customers that only three cycle times were possible (10 days, 15 days, 20 days), with decreasing prices. Urgencies were only considered under condition that the customer was ready to pay for shorter cycle times.

### 3.6 Information sharing

As already stated, many SMEs are facing a variable demand, which they can hardly satisfy at low cost. Even if some orders are not as urgent as others, this information is often not communicated by the customer. As a consequence, the SMEs have to make their decisions, on the priority of orders, grouping of similar orders, adjustment of lot sizes etc., on the only base of internal considerations. In the case studies, we have nevertheless seen that some customers share information with their suppliers in order to allow them to make their decisions to the benefit of both partners.

**Example:** A large company was sending the level of its present inventory together with each order, for showing his suppliers what could be the consequence of a tardy order. Sharing information on the inventory level gives to the supplier information on the customer's priorities when it is necessary for him to postpone orders, and increases his flexibility when constraints occur locally.

### 3.7 Lot sizes

Lot sizes are an important item, negotiated in the contracts. Nevertheless, SMEs have to decrease their costs through time, and have so to find solutions for constantly increasing the efficiency of their production system. In order to do this, some of them may need to provisionally increase their lot sizes. Therefore, many suppliers tried to group several orders from their customers in order to decrease their set-ups.

**Example:** An SME specialized in turning was exporting the planned orders to an Access® application aiming at grouping them according to the diameter of the parts, since this was not possible using their production management system. Since their application was not taking into account the due dates,

the result was both early and late orders that were then negotiated individually with the customer.

## 3.8 Conclusions of the study

Nearly all the large companies consider that the process described in Fig. 1 is the only possible to efficiently manage a supply chain. Therefore, suppliers' behaviours that are not consistent with this framework are considered as a sign of poor maturity, with the result of many projects aiming at the so-called "supplier development" (Wen-Li, 2003). We suggest to have a different attitude, and to consider that the practices of the suppliers, even if they lead to problems, are the symptoms of real concerns. Therefore, we suggest to turn these "hidden" practices into public ones, subject to negotiation with the partner. In order to illustrate this, we have focussed on four points, which are detailed in next section.

## 4. NEGOTIATION WITHIN THE MRP FRAMEWORK

### 4.1 Period of forecast

As mentioned previously, the forecasts in the aeronautical industry usually consist of firm, flexible and free periods. As seen during the interviews, practical issues concerning the periods of the forecasts are for instance the link between the firm period and the cycle time of the orders, or the link between the lengths of the periods received by the customer, and those he sends to his supplier. Therefore, we propose to put the periods of forecast into a middle term negotiation process, being defined on the base of the real requirements and actual necessities of both the customer and supplier.

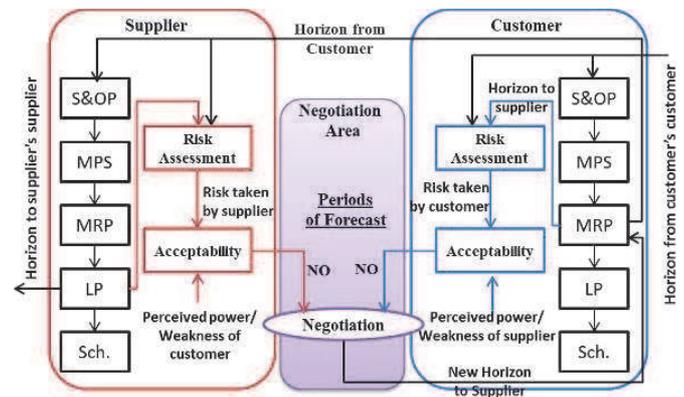


Fig. 2. Negotiation on the periods of forecast

Fig. 2 presents the information flow between the different MRP steps and the negotiation activities concerning the periods of forecast. The information required for risks assessment is obtained, on the customer's side, from a comparison between the results of the MRP calculation and the horizon from their own customer (right part of the figure). The same problem is detected by comparing the load planning and the forecasts sent by their customer on the supplier's side (left part of the figure). Based on the results of risk assessment, negotiation of the periods of forecast may be

performed if the supplier or the customer considers the current risks as unacceptable.

#### 4.2 Load variation

In case of load variation, instead of considering that the supplier HAS to answer to an overload if it is consistent with the contract, or CANNOT answer to an overload, we suggest that overloads (or lacks of loads) could also be negotiated, including setting into question the price paid by the customer.

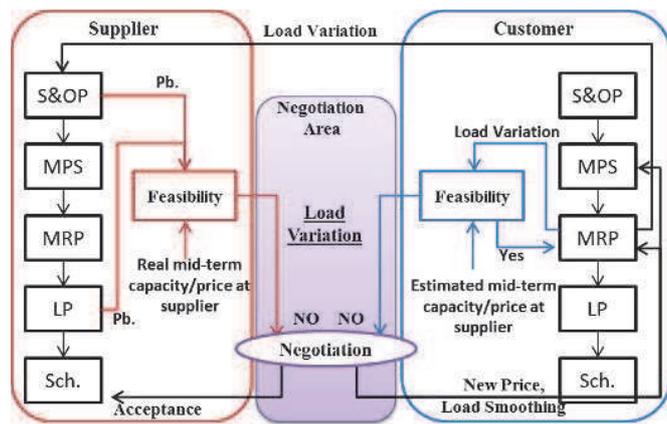


Fig. 3. Negotiation on the load variation

Therefore, we suggest to negotiate load variation problems, either resulting from constraints at the supplier's or customer's side, with a direct link with the price (increase if the problem comes from the customer, decrease if the problem comes from the supplier). Fig. 3 presents the information flow during the negotiation on the load variation. On the customer's side, information concerning the load variation is estimated at the MRP level, while real problems of capacity/load balance are usually detected in the S&OP and load planning level on the supplier's side. According to their situations, the supplier and customer may both request a negotiation on the load variation.

#### 4.3 Prices and cycle time

Urgencies are detected at the customer's side, but when facing these urgencies, it is the supplier who is challenged through its flexibility and adjustment of capacity.

We shall consider here that the cycle time of urgent orders is negotiable, as well as the price. When an urgent demand occurs, the customer should pay for the cycle time he expects according to the situation of his supplier; for instance, no increase of price would be required if the supplier is in an under loaded period. In other cases, a negotiation process on the price and cycle time is suggested to cope with the constraints coming from the supplier's capacity.

Fig. 4 presents the information flow during the proposed negotiation on price and cycle time. On the customer's side, the information for assessing the feasibility of an urgency is achieved at the MRP and load planning levels, while operational problems for dealing with such urgency come

from the load planning and real-time scheduling level on the supplier's side. The result of the negotiation should be a new price and due date after the negotiation.

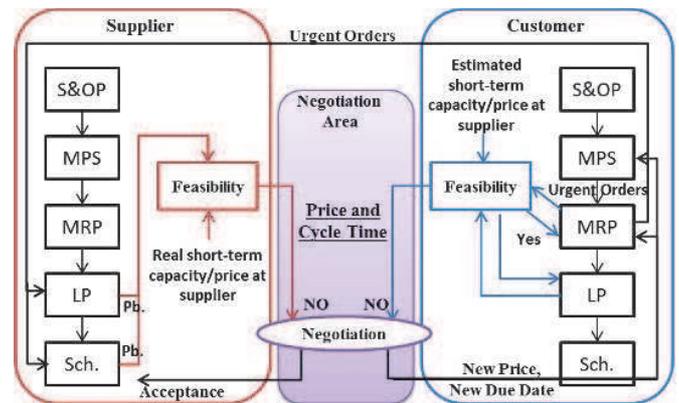


Fig. 4. Negotiation on price and cycle time

#### 4.4 Orders priority and Lot sizes

The final item we suggest to put into the negotiation process is the orders priority and lot sizes. From the interviews, we have seen cases where SMEs try to regroup orders having common features, in order to decrease the set-up times by increasing the lot sizes. Without additional information from their customers, the suppliers use an internal priority for scheduling the orders at the operational level, if all the orders cannot be fulfilled in time, as well as when urgent orders are required. As a consequence, tardy orders towards one or several customers may occur. Temporal margins or safety stocks may allow the customer to face delayed delivery on some of the orders, but this information is not always shared with the suppliers.

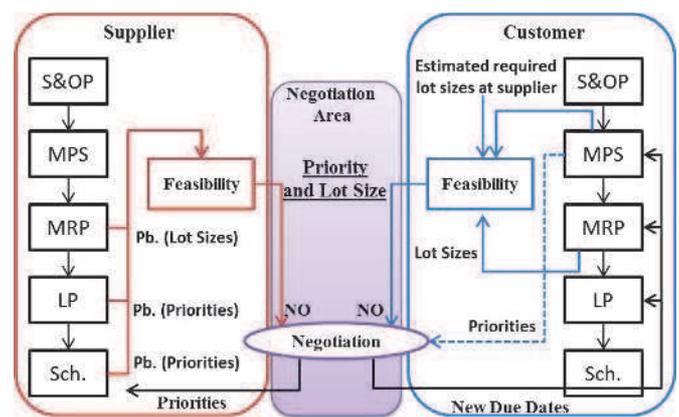


Fig. 5. Negotiation on priority and lot sizes

We have chosen here to group these two issues in the same point (see Fig. 5), since they both deal with operational planning. We have seen that practices have been detected in our case studies aiming at decreasing this problem: see the large company sharing the information on his inventory, allowing its supplier to have a better vision of the real priority of the orders. This allows the supplier to make better decisions when it is necessary to postpone orders. We have also seen that minimum lot sizes can be agreed when the

contract is established. In order to go one step further, we suggest to include these points in a negotiation process, at middle term (lot sizes) then short term (priorities). Again, extra payment would be an element of the negotiation.

Fig. 5 shows the information flow concerning the negotiation on priority and lot size. On the supplier's side, lot sizes problems are detected at the MRP level, while the problems linked to priorities are detected at the load planning and real-time scheduling levels. On the customer's side, problems linked to the lot size considered as acceptable for their supplier ("estimated lot size" in Fig. 5) can be detected at the MPS level, according to the information produced in the MRP level. If the negotiation is performed, the customer could provide information about its internal priorities, which is usually hidden to the supplier, in order to reach mutual agreement.

## 5. EXAMPLE OF NEGOTIATION PROCESS

After having globally defined the modalities of negotiation, we have defined precise negotiation processes aiming at allowing a simulation, which would help us to identify the possible context of interest of such collaborative process. In that purpose, each negotiation process has been modeled using first the Business Process Diagram (BPMN, 2011).

All the processes cannot be detailed here, but in Fig. 6 is shown the Business Process describing negotiation on periods of forecasts with more details. Normally, forecasts coming from customer's customer are inputs of the S&OP plan, then used to generate the MPS (Master Production Schedule) (point ① in Fig. 6). The MPS sends more detailed requirements on material and production to the MRP (Material Requirement Planning) module (point ②). The supply plan, an output of MRP, is generated based on the BOM (Bill Of Material), supply lead time, material inventory level, etc., according to the contractual time fences, including the firm, flexible and free periods (point ③).

The supply plan is received by the supplier and considered as forecasts (point ④). The supplier makes his own MRP calculation (point ⑤), resulting in his supply plan and load plan (point ⑥). Since he has taken into account his cycle time and the cycle time of his suppliers, the supplier is able to see whether this load plan is consistent or not, or in other terms whether he takes too much risks (for instance by ordering parts on the base of the flexible period of forecasts, point ⑦). Depending on the additional information on his customers and suppliers (such as: can they be urged or not, do they have financial stability or not), he decides whether these risks are acceptable or not (point ⑧). If he considers that he takes more risks than his partners (customers and suppliers), he may ask for negotiation (point ⑨).

The customer makes his own assessment of both internal risks and risks on supplier's side (point ⑩). This assessment of course considers the horizon of the firm period received from his customer, the horizon of the firm period he sends to his suppliers, his internal cycle time, supplier's cycle time,

etc. It should also include his opinion on additional external information like cycle time from supplier's suppliers, the real costs of his suppliers, etc. It is clear that this information is usually not provided by the supplier, who would not accept to communicate his real costs to his customer.

The risk taken by the customer is in some way proportional to the difference between the horizon he receives and the horizon he sends. It can be different for each of his suppliers, since two different suppliers do not need the same protection, or in other words do not deserve that the customer takes the same risk. It is for instance acceptable to take risks for protecting a critical supplier, but not for a common one. Such assessment will provide a customer's vision on the allocation of risks between the customer itself and his suppliers.

The next step is to balance the customer's and supplier's strength, aiming at identifying whether it could compensate the risks, and then assessing the acceptability of the risks taken by the customer (point ⑪). For instance, the customer may consider that he should take lower risks if his supplier has more "strength" than him. If, from customer's vision, risks are not acceptable, he will request for negotiation (point ⑫). Otherwise, the customer will accept the current plans (point ⑬).

## 6. CONCLUSIONS

Even if local cooperative processes are already in use in supply chains, we do think that collaboration should be extended in order to increase the global performance of the supply chains. In that purpose, we suggest here to turn hidden practices, often creating more problems than they solve, into official ones, performed through negotiation. The goal is to finally obtain a real win-win relationship. Of course, negotiation processes like the ones suggested here are only possible in a climate of trust between partners, which is not always observed in reality. An analysis of this point can be found in (Ming et al., 2011).

A second point is to demonstrate that these negotiation processes can really result in win-win situations. In order to validate this hypothesis, we have developed a simplified cost model which is the base of tests which are now in progress, aiming at better identifying in which case negotiation on the suggested items can be of mutual benefit.

As a third perspective, we would like to formalize with more details the notion of "risk" as considered here, which remains very subjective. In that purpose, we would like to better quantify the financial risks taken. This will require to use the cost model which is under development, but it will also necessitate to formalize more global issues allowing to assess the financial "health" of a company.

Finally, we have begun to present this study to industrial partners in order to get their first comments. Indeed, this reaction has been more positive than expected: nearly all the companies consider that there is a real source of improvement in such methodologies, but all of them also agree on the difficulty to reach the situation of trust which is a prerequisite for it.

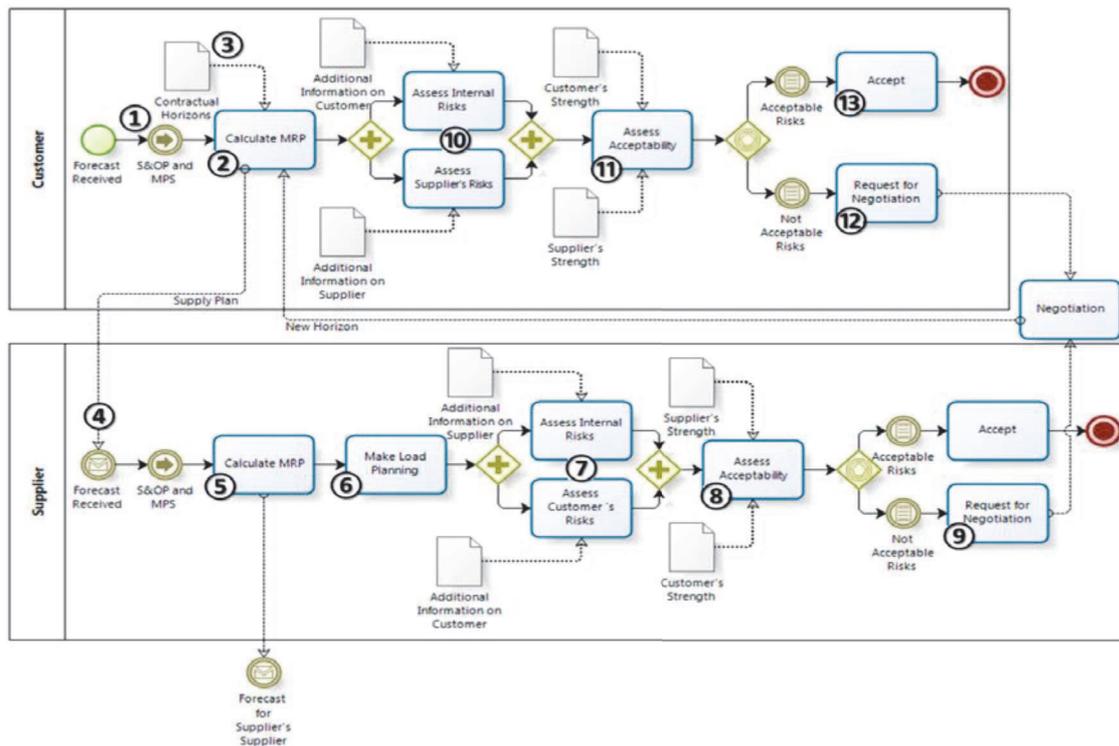


Fig. 6. Business Process Diagram of period of forecast negotiation

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