TACTICAL PLANNING FOR OPTIMAL CASH FLOW AND VALUE SHARING IN SUPPLY CHAIN

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Abstract: This paper shows tactical links and impact between physical flow and financial flow in a supply chain and propose an approach to share value between supply chain partners. The target is to obtain trade-off solutions during process operations preserving liquidity and satisfying customers. The proposed formalization combines a deterministic cash flow management model with a multi site planning using a MILP formulation. The benefits of this work are shown through a case study that illustrates the problem, the flows and constraints necessary to help high level staff during tactical planning and financial activities in supply chain.

Keywords: Tactical planning, Supply chain, Cash flow, value sharing, MILP.

1 Introduction

Collaborative relationships between firms deal with physical, informational and financial flow in Supply Chain. Many definitions of a supply chain can be given (Beamon, 1998). A Supply Chain exists if partners earn money thanks to collaboration. Therefore, a supply chain may be defined as a coalition of autonomous actors coordinated thanks to an integrated logistic process. Supply chain actors have to share value (cash flow), which is obtained thanks to collaborative planning. Many works (Dudek and Stadtler, 2005), (Holweg *et al.,* 2005),… deal with collaboration in supply chain, but financial aspects are always neglected: the shared value is always theoretical and deals with costs, not with cash. A study of Supply Chain manager interest for integration of financial impact on operational and tactical planning (Vickery *et al.,* 2003) shows that managers are really interested by tools which integrate financial and customer aspects in optimization.
Our paper deals with tactical links between physical and financial flow in a Supply Chain planning. Among works which propose to analyse the impact of physical flow in financial flow (Vidal *et al*., 2002), very few of them show relationships between cash flow and planning in tactical or operational terms. Our perspectives are to prove the relevance of integrating financial aspects in Supply Chain tactical planning and to share value (cash flows) obtained by actors collaboration. The paper is organized as follows: Section 2 shows previous work about cash management and gives a review about tactical planning in Supply Chain. Section 3 presents a generic modelling framework for optimal cash flow and sharing value between partners in Supply Chain. In section 4, we present our results based on a case study.

2 Cash management and tactical planning for supply chain: a literature review

Supply Chain tactical planning consists in determining quantity of items manufactured or transported by the supply chain capacity on a given horizon. Most of the papers about supply chain planning propose mathematical models in order to achieve this goal. All these models rise from a lot sizing model called "Multi-Level Capacitated LotSizing Problem" (MLCLSP). This one, developed by (Bellington *et al.,* 1983), links together different production planning with the assistance of a matrix called “Gozinto”. From this basic model, specific « multi-site » models have been developed for two decades. (Rizk and Martel, 2001) propose a review of the lot sizing literature dedicated to supply chain. For example, (Thierry, 1994), (Spitter *et al.,* 2004) and (Gnoni *et al.,* 2003) proposed mathematical approach dedicated to multi site planning. Whereas these models differ on hypothesis, the considered variables are similar. For example the quantity of item i manufactured in factory j during the period t is called $Q_{i,j,t}$, as well as the quantity of item i transported to an entity j from to an entity k during the period t is called $Q_{i,j,k,t}$. These variables can be considered like generic variables of supply chain tactical planning. In many scientific papers, it is written that Activity Based Costing (ABC) system is one of the best type of cost model for complex manufacturing system because of its connections with Supply Chain management (Shapiro, 1999), (Gupta and Galloway, 2004), (Gunasekaran and Sarhadi, 1998)… Activity Based Costing was introduced by (Cooper and Kaplan, 1991). If theoretical works are done on ABC modeling and Supply Chain management (Hombourg, 2004), (Boons, 1998), (Bih Ru and Fredendal, 2002), very few works deals with ABC using in Supply Chain production planning evaluation. Connections of tactical production planning and ABC are presented by (Ozbaayrak et al., 2004) and (Schneeweiss, 1998) but the aim of their work is to evaluate production strategies in flexible manufacturing system thanks to ABC tools, not to evaluate Supply Chain planning tactical Planning.

Managing a firm's cash is very important for its operational and financial success. The objective of cash manager is to have enough cash to cover the day-to-day operating expenses but to have as little excess cash as possible because cash is not a productive asset. By having excess cash in account, a company loses the potential interest (an opportunity cost) generated by investing money in securities. This implies that firm has to maintain a balance between amount of cash sitting in account and cash invested in securities**.** Cash management problem was simply formulated by (Baumol, 1952) as an inventory problem assuming uncertainty (Miller and Orr, 1966). Two types of metric are generally used to optimize financial flow: cash position which reveals the cash which is available in the end of a period and cash flow which reveals cash generate during a period. In a recent paper (Bertel *et al.*, 2005) show the links between financial flow and physical flow in an operational way and gives a state of the art about cash management and planning. The authors conclude that there is no scientific work which integrates financial aspect and physical aspect in tactical planning for Supply Chain. As shown by (Badell *et al.,* 2005), integrating financial flow and physical flow in planning in Supply Chain is essential to optimize financial flow.

Therefore, there are very few planning approaches which are evaluated with ABC tool or from cash flow point of view. There is just one approach (Comelli *et al.,* 2005) which proposes to evaluate thanks to ABC and cash flow level the impact of physical flow planning on financial flow. The authors propose a mathematical formalization of cash flow evaluation for a Supply Chain tactical planning: we propose to use this approach to integrate together financial and cash management objectives with physical constraints in objective function of programming mathematical model. A modelling which uses and improves this approach by giving a way to share value between partners in supply chain is given in next section.

3 A modelling for tactical planning and financial optimization

In order to produce an equitable distribution of value among channel partners collaborative planning is needed. In this section, the conceptual principle of the generic evaluation model is presented in the first paragraph; in the second paragraph, a global financial optimization is given, and the assignment of price in order to share the created value is given in the last paragraph.

3.1 Conceptual principle of the approach

In our approach, we make use of the term ‘‘transfer pricing’’ even though more than one company is concerned to underline the nature of the supply chain as one profit generating entity. Each autonomous entity crossed by logistic process is seen as a business unit of the supply chain. Each business unit of the supply chain sells and buys items with a negotiated price. Therefore, we propose to share value (cash flow) between entities of the supply chain as if the supply chain is considered like a single entity, and not to take into account the supply chain legal view. Because of logistic process indirect expenditure, we need to use cost drivers and to mix ABC approach and cash flow evaluation. Global cash flow of supply chain is independent of the transfer prices/ or market price between internal entities. Hence, cash flow optimization is feasible without assigning initial prices between internal entities of the supply chain. Once the global cash position determined, it will be possible to share the value between entities thanks to prices assignments. Thus, in order to achieve this goal, we propose two MILP (Mixed Integer Linear Program) chained together. The first one (Model A), gives tactical planning. The variables of this model are the quantity of item *i* bought, sold or manufactured by each entity of the SC. A maximal Supply Chain cash flow is then determined. These variables become the parameters of the second model (Model B) which aim is the value sharing. In this model, we determine the prices which allow us to specify the cash flow and the cash position of each entity. Figure 1 presents the proposed chaining of mathematical models.

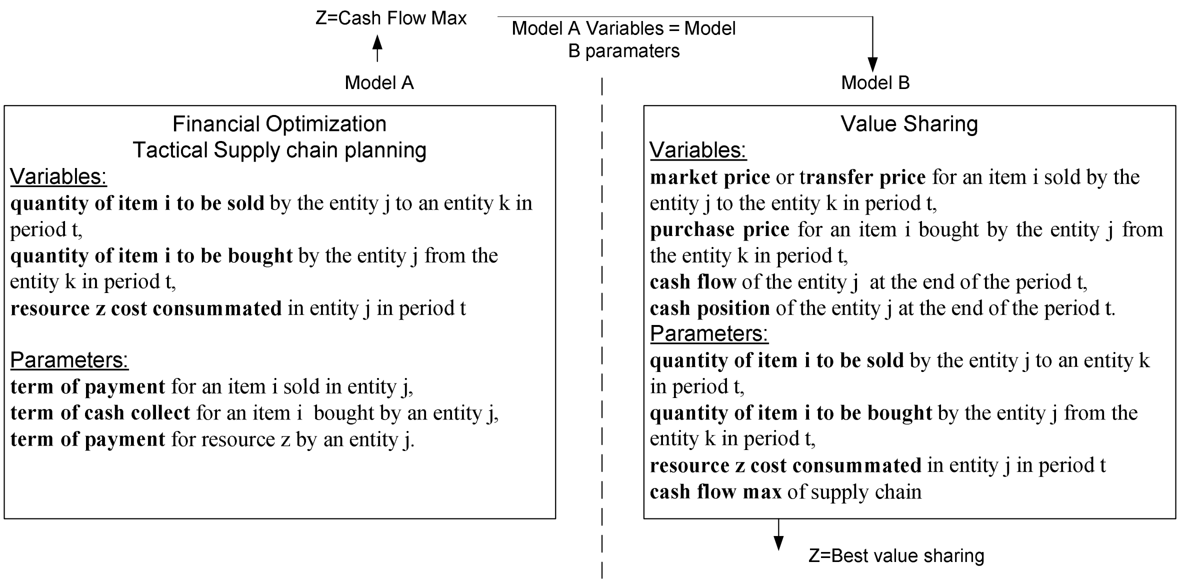


Figure 1. The proposed approach

3.2 Cash flow optimization

We propose to integrate together financial and cash management objectives with physical constraints in objective function of programming mathematical model in order to give the best trade-off solutions. Judging from the state of the art, they only differ according to considered hypothesis (set up, backlogging, transportation times…). Nevertheless, theirs variables are similar for cash flow evaluation. Our approach consists in adding objective function and financial constraint to tactical planning model (Model A). Thus, the mathematical model constituted of a financial objective function and financial constraints is generic and can be adapted to different Supply Chain tactical planning model:

$$Max\ z = \sum_{t=1}^{T} \sum_{j=1}^{J} \left[\sum_{i} \sum_{k=J+1}^{K} \left(QV_{i,j,k,t-h_{i,j}} \times PV_{i,j,k,t-h_{i,j}} - QA_{i,j,k,t-l_{i,j}} \times PA_{i,j,k,t-l_{i,j}} \right) - \sum_{z} R_{j,t-g_{1,z},z} \right] \quad (1)$$

$$\forall (j,t,z) \in [\![1,J]\!] \times [\![1,T]\!] \times [\![1,Z]\!]$$

$$R_{j,t,z} = \begin{cases} \left(\sum_i Cd_{i,j,t,z} \times Q_{i,j,t} \right) + Cid_{j,t,z} \times Ic_{j,t} & \forall (j,t,z) \in [\![1,J]\!] \times [\![1,T]\!] \times [\![1,Z]\!] \\ 0 & \forall t \le 0 \end{cases} \quad (2)$$

$$\forall t,\ \forall (i,j,k) \in [\![1,I]\!] \times [\![1,J]\!] \times [\![1,J]\!] \quad PA_{i,j,k,t} = PV_{i,k,j,t} \quad (3)$$

Where I is number of items; J is number of business unit in Supply Chain; K is number of external and internal entities; T is number of periods, and Z is number of resources. $Cd_{i,j,z,t}$ is direct cost of item i for the resource z in the entity j in period t; $Cid_{j,z,t}$ is indirect cost of resource z in the entity j in period t, $PV_{i,j,k,t}$ is market price or the transfer price for an item i sold by an business unit j to an business unit k in period t; $PA_{i,j,k,t}$ is purchase price for an item i bought by an business unit j from the an k in period t, $h_{i,j}$ is term of payment for an item i sold by an business unit j; $l_{i,j}$ is term of cash collect for an item i bought by an business unit j; $g_{j,z}$ is term of payment for resource z by an business unit j.
The variables are as follows: $QV_{i,j,k,t}$ is quantity of an item i sold by the business unit j to the business unit k in period t; $QA_{i,j,k,t}$ is quantity of item i to be bought by the business unit j from the business unit k in period t; $R_{j,t,z}$ is resource z cost consummated in business unit j in period t; $Q_{i,j,t}$ is quantity of item i produced by the business unit j in period t, $Ic_{j,t}$ is cost driver of business unit j in period t.

Comments: We propose to optimize the Supply Chain cash flow (1) defined by (Comelli *et al.*, 2005). Specifying the cash flow of each business unit is useless, because of the global optimization is independent of product transfer pricing between internal entities. Thus, we only consider product exchanges between the SC and its external companies, as well as the resources consumption of each SC business unit. The constraint (2) gives the definition of the resource z cost consummated by business unit j in period t. The constraint (3) specifies that the transfer price between two internal entities is equal to the purchase price between the same entities.

Adding financial optimization to tactical Supply Chain model consists in expressing financial variables according to physical variables. More precisely, we have to express the quantities of items bough $QA_{i,j,k,t}$ or sold $QV_{i,j,k,t}$ as well as cost drivers ($Ic_{j,t}$) according to $Q_{i,j,t}$ or $QT_{i,j,k,t}$ defined in previous section as generic variables. Cost drivers explain the process consumption and are defined thanks to the system specification. Concerning $QA_{i,j,k,t}$ and $QV_{i,j,k,t}$, theirs expressions depend on the Supply Chain structure and more particularly on the business unit definition. Indeed, according to assignments of inventories among Supply chain entities, quantity of item sold or bought can be expressed differently according to physical variables. Hence, if the business unit is defined as:

- *an entity unit with upstream and downstream inventories, so* $QA_{i,j,k,t}$ *is equal to* $\sum_{k'} QT_{i,k',j,t}$ *and* $QV_{i,j,k,t}$ *is equal to* $\sum_k QT_{i,j,k,t}$.
- *an entity with only downstream inventories, so* $QA_{i,j,k,t}$ *is equal to* $Q_{i,j,t}$ *and* $QV_{i,j,k,t}$ *is equal to* $\sum_k QT_{i,j,k,t}$.
- *an entity with only upstream inventories, so* $QA_{i,j,k,t}$ *is equal to* $\sum_{k'} QT_{i,k',j,t}$ *and* $QV_{i,j,k,t}$ *is equal to* $Q_{i,j,t}$.
- *an entity without inventory, so* $QA_{i,j,k,t}$ *is equal to* $Q_{i,j,t}$ *and* $QV_{i,j,k,t}$ *is equal to* $Q_{i,j,t}$.

Thanks to these assignments, it's possible to adapt both mathematical models in order to conceive a tactical planning obtained thanks to financial optimization. Adding financial objective function allow us to compare a tactical planning obtained thanks to financial objective function with an other one obtained thanks to physical objective function.

3.3 Value Sharing

The second part of our approach consists in proposing a mathematical model (Model B) sharing the value among entities belonging to the same Supply Chain. Regarding section 1, value sharing depends on numerous parameters (term payment …).
Thanks to the first model, Supply Chain cash flow (CF_{max}) is determined. Assigning prices (transfer pricing if entities are in the same firm) allows easily sharing value generated by collaboration. Thanks to cash flow evaluation given by (Comelli, *et al.*, 2005), it's possible to obtain the cash flow and the cash position for each business unit. We propose a MILP with an objective function which favours a fair sharing, but others objective functions could have been implemented. In order to achieve this goal, we propose to maximise the lowest cash position.

<u>Objective function:</u> $Max\ z$

$$\forall (t,j) \in [\![1,T]\!] \times [\![1,J]\!] \quad z \le Tres_{j,t} \tag{1}$$

$$\forall (t,j) \in [\![1,T]\!] \times [\![1,J]\!]$$
$$CF_{j,t} = \sum_{k=1}^{K} \sum_{i} \left(QV_{i,j,k,t-h_{i,j}} \times PV_{i,j,k,t-h_{i,j}} - QA_{i,j,k,t-l_{i,j}} \times PA_{i,j,k,t-l_{i,j}} \right) - \sum_{z} R_{j,t-g_{j,z},z} \tag{2}$$

$$\forall t \in [\![1,T]\!] \quad CF_t = \sum_j CF_{j,t} \tag{3}$$

$$CF_{\max} = \sum_t CF_t \tag{4}$$

$$\forall t \in [\![1,T-1]\!] \quad Tres_{j,t+1} = Tres_{j,t} + CF_{j,t+1} \tag{5}$$

$$\forall (i,j,k,j',t) \in [\![1,N]\!] \times [\![1,J]\!] \times [\![1,J]\!] \times [\![1,J]\!] \times [\![1,T]\!]$$
$$PV_{i,j,k,t} \le PV_{i,k,j',t} \text{ , j' successor of k in Supply Chain structure} \tag{6}$$

$$\forall (i,j,k,j',t) \in [\![1,N]\!] \times [\![1,J]\!] \times [\![1,J]\!] \times [\![J,K]\!] \times [\![1,T]\!]$$
$$PA_{i,j',k,t} \le PA_{i,j,k,t} \tag{6'}$$

$$\forall (i,j,k,j',t) \in [\![1,N]\!] \times [\![1,J]\!] \times [\![1,J]\!] \times [\![J,K]\!] \times [\![1,T]\!]$$
$$PV_{i,j,k,t} \le PV_{i,k,j',t} \tag{6''}$$

$$\forall t,\ \forall (i,j,k) \in [\![1,I]\!] \times [\![1,J]\!] \times [\![1,J]\!] \quad PA_{i,j,k,t} = PV_{i,k,j,t} \tag{7}$$

$$\forall (j,t) \in [\![1,J]\!] \times [\![1,T]\!] \quad Tres_{j,t} \ge Tres\min_{j,t} \tag{8}$$

$$\forall t \le 0,\ \forall (i,j,k) \in [\![1,I]\!] \times [\![1,J]\!] \times [\![1,J]\!] \quad QV_{i,k,j,t} = 0 \tag{9}$$

$$\forall t \le 0,\ \forall (i,j,k) \in [\![1,I]\!] \times [\![1,J]\!] \times [\![1,J]\!] \quad QA_{i,k,j,t} = 0 \tag{10}$$

Where: $h_{i,j}$ is term of payment for an item i sold by an entity j; $l_{i,j}$ is term of cash collect for an item i bought by an entity j; $g_{j,z}$ is term of payment for resource z by an entity j; $QV_{i,j,k,t}$ is quantity of item i

sold by the entity *j* to the entity *k* in period *t*; $QA_{i,j,k,t}$ is quantity of item *i* bought by the entity *j* from the entity *k* in period *t*; $PV_{i,j,k,t}\ \forall (j,k) \in [\![1,J]\!]\times[\![J+1,k]\!]$ is market price or transfer price for an item *i* sold by the entity *j* to an external entity *k* in period *t*; $PA_{i,j,k,t}\ \forall (j,k) \in [\![1,J]\!]\times[\![J+1,k]\!]$ is purchase price for an item *i* bought by the entity *j* from an external entity *k* in period *t*; CF_{max} is cash flow max of Supply Chain.
The variables are as follows: $PV_{i,j,k,t}\ \forall (j,k) \in [\![1,J]\!]\times[\![1,J]\!]$ is market price or transfer price for an item *i* sold by the entity *j* to the entity *k* in period *t*; $PA_{i,j,k,t}\ \forall (j,k) \in [\![1,J]\!]\times[\![1,J]\!]$ is purchase price for an item *i* bought by the entity *j* from the entity *k* in period *t*; CF_t is cash flow of the SC at the end of the period *t*; $Tres_{j,t}$ is cash position of the entity *j* at the end of the period *t*.

Comments: Constraint (2) and (3) define the cash flow of each Supply Chain entity and the Supply Chain cash flow for each period. Constraint (4) specifies that the sum of the Supply Chain cash flow is known and is equal to CF_{max}. Constraint (5) gives the definition of the cash position of each entity. With constraint (6), we assume that value created by an entity is taken into account in the transfer price assignment. Constraints (6') and (6'') verifies that prices between Supply Chain entities are lower than final customer prices and higher than purchase prices. Constraint (7) specifies that sold prices between two business units are equal to the purchase price between them. Constraint (8) guarantees that the defined value sharing respects a minimal cash position for each business entity for each period.

In next section, we apply both models on a Supply Chain.

4 A case study

In paragraph one, we give a case study presentation. In paragraph 2, we give a specification on the studied case of the proposed modeling. Last paragraph gives computational results.

4.1 Case study presentation

The company Supply Chain is constituted of 3 firms called A, B and M. Respectively, each firm A, B and M are constituted of two Business Unit, called B1 and B2, B3 and B4 and B5 and B6. Physical and financial flows are presented by the figure 2. Warehouses are divided among business units according to figure 2. Initial transfer prices between supply chain business unit are given by table 1.

Item	$PV_{i,1,2}$	$PV_{i,1,3}$	$PV_{i,1,4}$	$PV_{i,2,5}$	$PV_{i,3,5}$	$PV_{i,4,5}$	$PV_{i,5,6}$
1	6	6	6	14	14	14	30
2	8	8	8	18	18	18	38
3	10	10	10	22	22	22	46
4	11	11	11	24	24	24	50
5	13	13	13	28	28	28	58
6	15	15	15	32	32	32	66

Table 1. Initial transfer prices

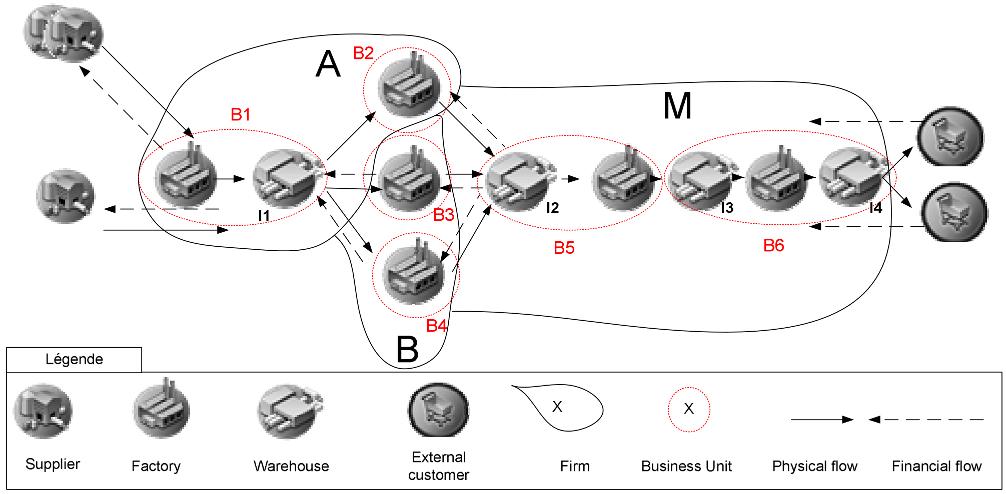


Figure 2. Supply Chain, Firms and Business Unit

4.2 Case study specification

We present a tactical Supply Chain planning model dedicated to this case study. The financial part of the model A is a specification of generic model presented in section 3 whereas the physical part is based on the multi site model given by (Thierry, et al, 2004).

$$Max\ z = \sum_t \left[\sum_i \left(Ds_{i,t-h_{i,6}} \times PV_{i,6,k,t-h_{i,6}} - Q_{i,1,t-l_{i,1}} \times PA_{i,k,1,t-l_{i,1}} \right) - \sum_j \sum_z R_{j,t-g_{j,z},z} \right]$$

$$\forall (i,t) \in [\![1,I]\!] \times [\![1,T]\!] \quad D_{i,t} = DS_{i,t} + DP_{i,t} \tag{1}$$

$$\forall (i,t) \in [\![1,I]\!] \times [\![0,T-1]\!] \quad \begin{cases} I_{i,0,t+1} = I_{i,0,t} - Q_{i,1,t+1} \\ I_{i,1,t+1} = I_{i,1,t} + Q_{i,1,t+1} - Q_{i,2,t+1} - Q_{i,3,t+1} - Q_{i,4,t+1} \\ I_{i,2,t+1} = I_{i,2,t} + Q_{i,2,t+1} + Q_{i,3,t+1} + Q_{i,4,t+1} - Q_{i,5,t+1} \\ I_{i,3,t+1} = I_{i,3,t} + Q_{i,5,t+1} - Q_{i,6,t+1} \\ I_{i,4,t+1} = I_{i,4,t} + Q_{i,6,t+1} - DS_{i,t+1} \end{cases} \tag{2}$$

$$\forall (i,t) \in [\![1,I]\!] \times [\![0,T-1]\!] \quad \begin{cases} Q_{i,1,t+1} \le I_{i,0,t} \\ Q_{i,2,t+1} + Q_{i,3,t+1} + Q_{i,4,t+1} \le I_{i,1,t} \\ Q_{i,5,t+1} \le I_{i,2,t} \\ Q_{i,6,t+1} \le I_{i,3,t} \end{cases} \tag{3}$$

$$\forall (i,j,t) \in [\![1,I]\!] \times [\![1,J]\!] \times [\![0,T-1]\!] \quad \begin{cases} Q_{i,j,t} \le C_{j,t} \times X_{i,j,t} \\ Q_{i,j,t} \ge X_{i,j,t} \end{cases} \tag{4}$$

$$\forall (j,t) \in [\![1,J]\!] \times [\![0,T-1]\!] \quad \sum_i Q_{i,j,t} \le C_{j,t} \tag{4'}$$

$$\forall (j,t) \in [\![1,J]\!] \times [\![1,T]\!] \quad Ic_{j,t} = \sum_i X_{i,j,t} \tag{5}$$

$$\forall (j,t,z) \in [\![1,J]\!] \times [\![1,T]\!] \times [\![1,Z]\!] \quad R_{j,t,z} = \sum_i Cd_{i,j,t,z} \times Q_{i,j,t} + Cid_{j,t,z} \times Ic_{j,t} \tag{6}$$

Where, $DS_{i,t}$ is satisfied demand of item i manufactured in period t, $DP_{i,t}$ is unsatisfied demand of item i in period t, $R_{j,t,z}$ is resource z cost consummated in entity j in period t, $I_{i,j,t}$ is quantity of item i held in inventory j in period t, $C_{j,t}$ is production capacity of the entity j in period t, $X_{i,j,t}$ is a binary variable indicating whether a set up for item j occurs ($X_{i,j,t}=1$) in the entity j in period t or not ($X_{i,j,t}=0$) and $Ic_{j,t}$ is cost driver of entity j in period t. We remember only parameters and variables which aren't specified in section 1.

Comments: The constraints (1) are the inventory balances. The constraints (2) express the periodicity constraint. The constraints (3) specify the set up constraints. The constraints (4) and (4') assume that each entity and each period have a limited capacity. The considered cost driver is the number of campaign for each entity and for each period (5). The constraint (6) defined the resource z cost consummated in entity j in period t.

The specification of the model B was obtained thanks to business unit definition explained in section 3. We present only the specification of cash flow in entity 1. Cash position and cash flows of other entities are easily deducted.

$CF1_t$ is Cash flow of the Entity 1 at the end of the period t:

$$CF1_t = \sum_i \begin{pmatrix} QF_{i,2,t-h_{i,1}} \times PV_{i,1,2,t-h_{i,1}} + QF_{i,3,t-h_{i,1}} \times PV_{i,1,3,t-h_{i,1}} \\ +QF_{i,4,t-h_{i,1}} \times PV_{i,1,4,t-h_{i,1}} - QF_{i,1,t-l_{i,1}} \times PA_{i,k,1,t-l_{i,1}} \end{pmatrix} - \sum_z R_{1,t-g_{1,z},z}$$

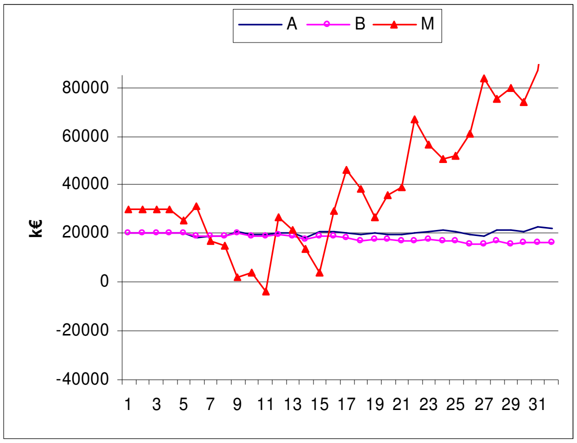
4.3 Results

The model A was implemented under AMPL, and tested with small industrial instances using CPLEX solver. We consider four instances. We obtain optimal solution for the two first one. Nevertheless, we present solutions obtained after a limit time equal to 10 minutes. These results are evaluated according to the two following metrics: Total Satisfaction Demand (TSD) and Cash Flow (CF). Table 2 synthesizes these results.

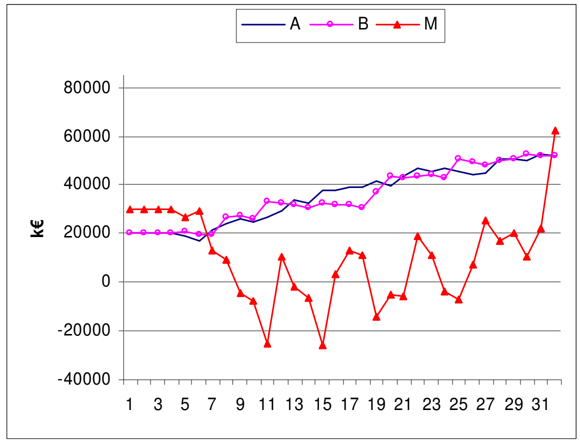
Periods	Items	Demand	TSD	DS	CF
16	3	720	75	540	11260
16	6	1440	73	1050	44810
31	3	1710	83	1419	27356
31	6	3420	83	2832	96049

Table 2. Instances Results

The model B was also implemented under AMPL, and tested with the same instances using CPLEX solver. We give optimal solution obtained for the instance (31 per, 6 items). Table 3 gives obtained prices and graph 1 gives cash position evaluation for each firm and each period. Then, we compare these results with those obtained with initial price (Table 1). Cash position at the end of horizon level obtained by both sets of prices is given by Table 4.



Cash position before value sharing



Cash position after value sharing

Graph 1. Cash position in supply chain firms before and after value sharing during time horizon

Item	$PV_{i,1,2}$	$PV_{i,1,3}$	$PV_{i,1,4}$	$PV_{i,2,5}$	$PV_{i,3,5}$	$PV_{i,4,5}$	$PV_{i,5,6}$
1	10	2	2	41	26	33	42
2	12	3	2	73	5	3	75
3	25	2	3	33	3	7	34
4	3	2	2	100	100	99	101
5	113	54	2	116	85	4	117
6	2	2	3	8	19	36	39

Table 3. Transfer price after value sharing

	Firm A			Firm B			Firm M			Optimal Cash flow for Supply Chain given by model A
	BU1	BU2	Global	BU4	BU5	Global	BU5	BU6	Global	
Without Value sharing	4448	-2150	2298	-1493	-2010	-3503	17523	79731	97254	96049
With Value sharing / Model B	16007	16007	32014	16007	16007	32014	16009	16012	32021	96049

Table 4. Cash flow obtained by collaboration before and after value sharing in Supply Chain Business Unit

Note that firms A and B have improved their situation after value sharing and that M position is not as good as before value sharing. Anyway, table 4 show that without value sharing, Firm B does not have interest to collaborate because Firm B lose money and destroy value.These results show how we can influence the cash position of entities according to prices. It‘s possible to note that transfer prices obtained by optimization are very different each other even for those concerning the same stage of Supply Chain. It would be interesting to study if others optimal solutions with less difference between prices of the same stage exist.

5 Conclusions

In this paper, we have proposed a global solution to integrate financial and physical flow in tactical planning in order to share value. We apply our MILP models on a study case in order to optimize supply chain working. Unfortunately the modelling approach can not guarantee conflict resolution or force a chain member to collaborate. However the MILP models provide some guidelines for realizing the opportunities in supply chain management.

The aim of our future work is to develop an efficient heuristic, and a global environment for supply chain evaluation. More other, we would like to introduce games theory in our model in order to take into account firm's behaviour in collaboration.

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