RAIRO-Oper. Res. 52 (2018) 187–204
https://doi.org/10.1051/ro/2017025

RAIRO Operations Research
www.rairo-ro.org

A SYSTEM DYNAMICS MODEL OF FINANCIAL FLOW IN SUPPLY CHAINS: A CASE STUDY

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Abstract. The article discusses the operational and financial relationships among the channel members of a supply chain comprising of a manufacturing company and a distributor. This research simulates the financial system that enables a more accurate diagnosis of disaggregated metrics "Cash to Cash", considering different interactions between material flow and the financial flow of the two links, manufacturer and distributor. This model considers the feedback loops between material flow models and financial models without which some interactions are lost during simulation. The proposed diagnostic method which incorporates an eclectic process re-engineering practices and state of the art of dynamic simulation with the implementation of advanced techniques of sensitivity and dynamic optimization models those are applied on the concept of stocks and flows. This methodology is used in order to analyze and improve business strategies by generating policies which help to improve cash flow of the company. To validate our model, a case study illustrating the improvement of different metrics of the supply chain is considered here. The results show that the companies have to invest in technology in order to generated strategic decision to enhance their financial metrics.

Mathematics Subject Classification. 90B05, 91G80, 90B50.

Received November 14, 2016. Accepted March 31, 2017.

1. Introduction

Liquidity is a critical factor in any business organization. It is currently estimated that 4% of the cost of the end products of a company is directly related to the financial costs [12]. For this reason, a change in liquidity can affect different areas in terms of quality, payments, purchases and other financial obligations. It is important to understand the relationship of these functional areas which help to the management to take better decisions in future. The cash flow can be defined as a necessary and indispensable tool in the financial management of a company and it aims to meet income and expenses over a period of time. This tool is used to raise and establish policies on the amount of financial investment, payment of dividends, returns deadlines, *etc.*

System dynamics (SD) is a computer aided, graphical and analytical approaches which depicts the behavior and features of the system over time in order to understand the behavior of the system by the policy makers. The modeling of dynamic systems allows completely different techniques to be used in order to studies at a socio-economic level which requires empirical data for their statistical calculations to determine the di-

Keywords. Cash flow, systems dynamics, supply chain.

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rection and the correlation between simulation factors [8]. Feng [7] discussed quantitatively the importance of information sharing in supply chain management by comparative analysis using system dynamics model. Huang *et al.* [10] examined two purchasing strategies: no backup supply, and with a contingent supplier, to find out the impacts of supply disruption on the retailer's inventory level and the customer's unsatisfied amount. Kumar and Kumar [15] developed a model on the rural supply chain of folic acid tabs in District Haridwar, Uttarakhand, India using system dynamics technique. A few researches have been developed in academia and industry regarding the financial management of supply chains through dynamic simulation.

Several authors have touched superficially the component "Cash Flow" in dynamic systems, such as models of accounts payable, accounts receivable, inventory, debt levels, workforce investment capital, financial planning, among others. We shall now focus on the following researches those are main focus of our proposed study.

1.1. Current cash flow simulation issues

Proper cash flow management is a critical element in many organizations. The policies of the companies' cash flow which manages working capital in the form of cash returns, inventories and cash payments to suppliers must be strongly committed for improving its financial performance [14]. Many organizations recognize that effective management of cash flow becomes an effective mechanism in order to improve performance [6] of supply chain. In recent years, the system dynamics applied to financial structures have attracted the researchers as well as practitioners of the industries. Thompson [34] analyzed the cash flow management based on the system dynamics. Kolay [13] described how the system dynamics could be successfully used for proper decision making when the company had insufficient capital. Bianchi [1] integrated the system dynamics models and accounting for planning and control of the financial system. Pejic-Bach [23] explained how the financial discipline is a major problem for small and developing businesses. The authors like Yingliang and Diagram [38], Petrosky-Nadeau and Wasmer [24] provided some of the most comprehensive financial planning in different financial models and scenarios, addressing the accounting part of the financial statements from the income statement to the balance sheet which is an important contribution to building theory and conceptual modeling.

1.2. Supply chain management simulation

Recently, significant research has been done on developing effective supply chain management in perspective of system dynamics. Papachristos [22] studied the link between capital goods supply chains and socio-technical transitions. Golroudbary and Zahraee [9] studied a simulation model to evaluate the system behavior of an electrical manufacturing company (a case study) using SD of Closed-loop Supply Chain (CLSC). Several authors like Minegishi and Thiel [18], Ozbayrak *et al.* [20], Pierreval *et al.* [25], Sarkar [27], Udenio *et al.* [35], Vlachos *et al.* [37], Yingliang and Diagram [38], Panda [21], Sarkar *et al.* [28–30] and Cardenas-Barron [2–4] studied the behavior and relationships of the channel members within a supply chain in order to determine the impact of key variables such as the variability of demand, lead time and inventory levels on the performance of the supply chain.

The main objective of the proposed project is to evaluate the long-term impact generated by the strategic decisions in the cash flow of each company and the supply chain. This impact is assessed with the metric C2C (cash to cash or cash cycle) which shows the time elapsed between a payment that is made to a vendor for raw material purchases, until the money is raised through the sale of products or services [11]. This paper proposes the simulation of the financial system in a new perspective where different interactions between material flow and the financial flow of two echelons as mentioned above. The metric C2C is relatively new compared to the existing dynamic simulation models that are commonly used, little common to find about cash flows and any related financial flow model.

2. Problem definition and assumptions

We develop a system dynamics approach applied to the effective management of cash flow in supply chains as a mechanism to improve financial and operational performance of each link of the chain. The O_c and O_x are

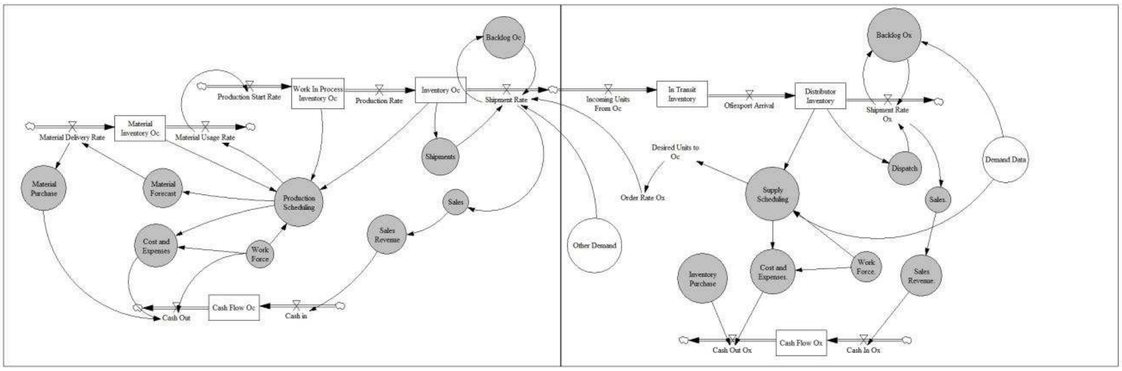

Figure 1. Representation of the supply chain and it's relation to the cash flow.

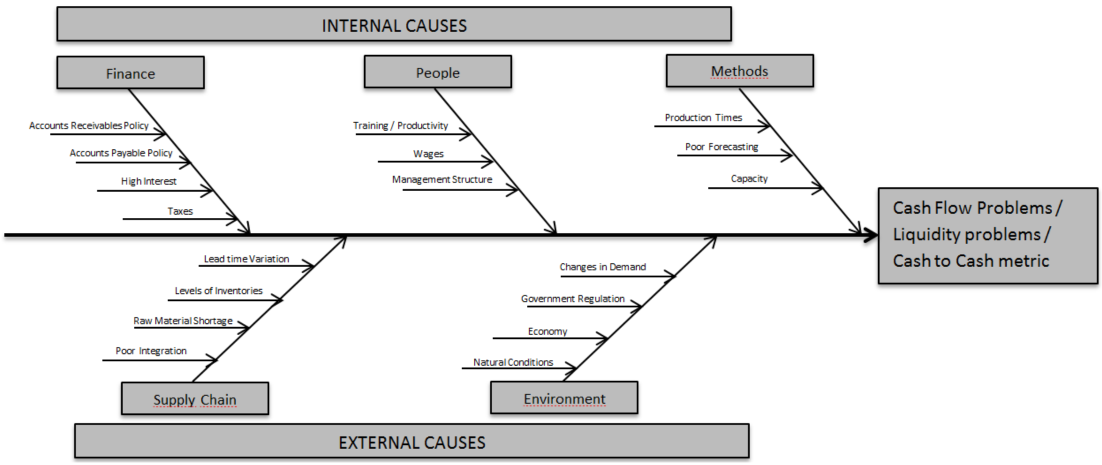

Figure 2. Cause and effect diagram.

used as acronyms for traditional push-based manufacturing and distributing companies respectively. Figure 1 presents a schematic diagram of a supply chain of two echelons (manufacturer and a distributor) and their relation to cash flow. Such supply chain receives raw material from its suppliers which are transformed into a final product. This final product is sold by the distributors who are responsible for marketing the product. The manufacturing company's cash flow increases with income from the sales of the finished product and decreases with the purchase of raw materials and the payment of costs associated with the activity. In the distribution company, cash flow is affected by the purchase of finished goods, the payment of costs associated with the activity and sales revenues.

The cause and effect diagram is implemented to examine the potential factors that could affect the cash flow of each link of the chain. For its construction, the external causes associated with market fluctuations, environmental conditions and public policies, and internal causes related persons, methods, operational and financial decisions are taken into account in our model. The cause and effect diagram is shown in Figure 2.

The construction of the cause and effect diagram was developed by Kumar and Nigmatullin [16]. There are three main internal causes: the first is associated with finances which include the collection and payments policies, payments of interest on loans and tax payments. The second internal cause is applied to the staff, training, productivity, wages and administrative structures. The third internal cause is related to methods, including production times, inefficient forecasts, and the capacity of each echelon. There are two main external causes regarding supply chain that include lead time variation, levels of inventories, raw materials shortage and poor integration. The Environment category includes the changes in demand, government regulation, economy and natural conditions. This includes the conditions of natural causes in which most of the raw materials are imported and purchased by maritime shipment. The importance of this diagram is that it allows the inclusion of the model variables that affect key financial and operational performance of the supply chain. Furthermore, it allows possible business scenarios where the impairments of the cash flow may have. After analyzing the high-level diagram shown in Figure 1 and diagram Figure 2, we can proceed to analyze all the variables included in the model as well as feedback loops that may occur in the structure and causal relationships that can generate reinforcement or balance. These feedbacks form the complex structure underlying the system dynamics model are presented in the next section.

2.1. System dynamic simulation

A system dynamics model is an interaction of feedback loops that form a complex structure with mathematical equations that define the relationship between the variables in the complex system [17]. The model is built on the concept of stocks and flows developed in the system dynamics methodology. The variables are identified as level, flow and auxiliary variables. The present study consists of two main models: The inventory model, which was used as the base developed by Sterman [32] and the cash flow model which was developed using the results of the cause and effect chart shown in Figure 2. Figure 1 shows the use of financial and operating policies reported by each echelon in the supply chain. The metric of C2C is calculated integrating two models (inventory and cash flow). To understand the structural causes of the system behavior, we need to comprehend the role of the development of the model and each element of the system and see how different actions affect behavioral tendencies within it. The purpose of this study is to evaluate in general the long-term impact generated by strategic, operational and financial decisions in the organization's cash flow of the supply chain. In this context, three major products referenced in the supply chain as Reference 1, Reference 2 and Reference 3 are studied and analyzed. To study the behavior of each of these products, we use parallel modeling with subscript Vensim software.

2.2. Manufacturing and distributor inventories model

The basic model originally developed by Forrester [8] and extended by Sterman [32], a solid foundation and widespread use in the literature, is considered to develop the inventory and production models for the manufacturing company and the distribution centre in this case study. The model can be divided into several sections. For practical purposes, it has been divided into 4 sections, taking into account the main variables that comprise the structure and generate corresponding behavior.

(1). *Inventory of raw materials (MI)*: Models of inventory of raw materials associated with this are the feedback loops and control the amount of commodity flow variables such as the rate of use of materials or exogenous variables as the desired amount of raw material.

(2). *Work in process inventory(WPI)*: In this case, inventories of semi-finished goods are modeled, the variables that make up this section are associated with the control of work in process, among which the desired amount of production and the cycle time of units are occurred.

(3). *Section completed Inventory (SCI)*: This part comprises of modeling inventories of finished goods. This section is attached with the rate of flow delivery and production rates which are modeled as a control feedback inventory.

(4). *Section accumulating orders (Backlog)*: This section models the logic that follows the orders those are generated for the technology associated with this part. These are flow variables at the rate of arrival of orders, delays associated in execution of these orders and associated feedback as fulfilling orders.

The manufacturing industry (Fig. 3) and the distribution company (Fig. 4) handle the same structure of inventory models. The variables of both models differ by the symbol O_c used in manufacturing company and O_x models used in the distributor.

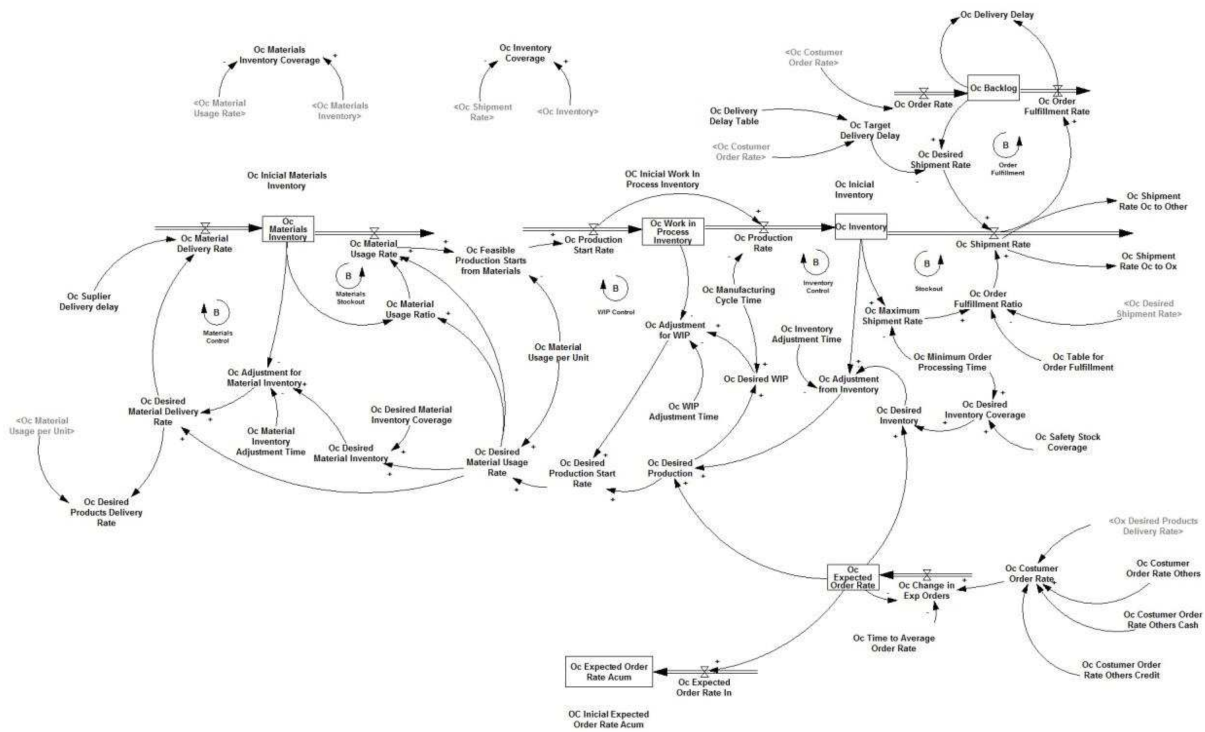

Figure 3. Inventory model of manufacturing company.

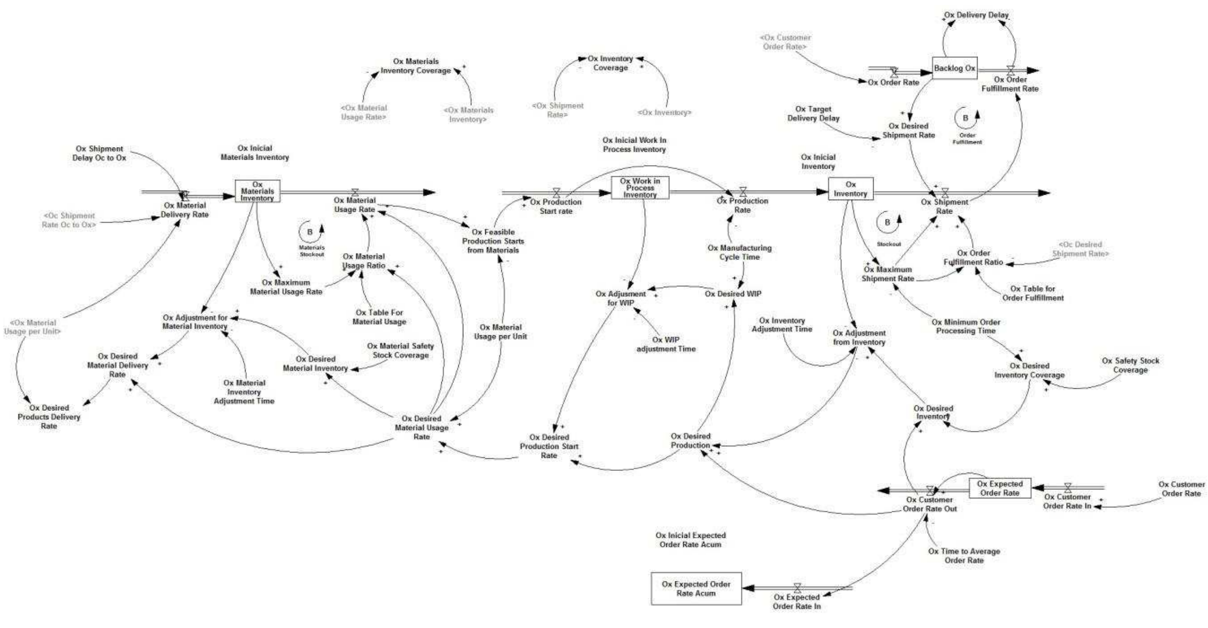

Figure 4. Inventory model of distributor.

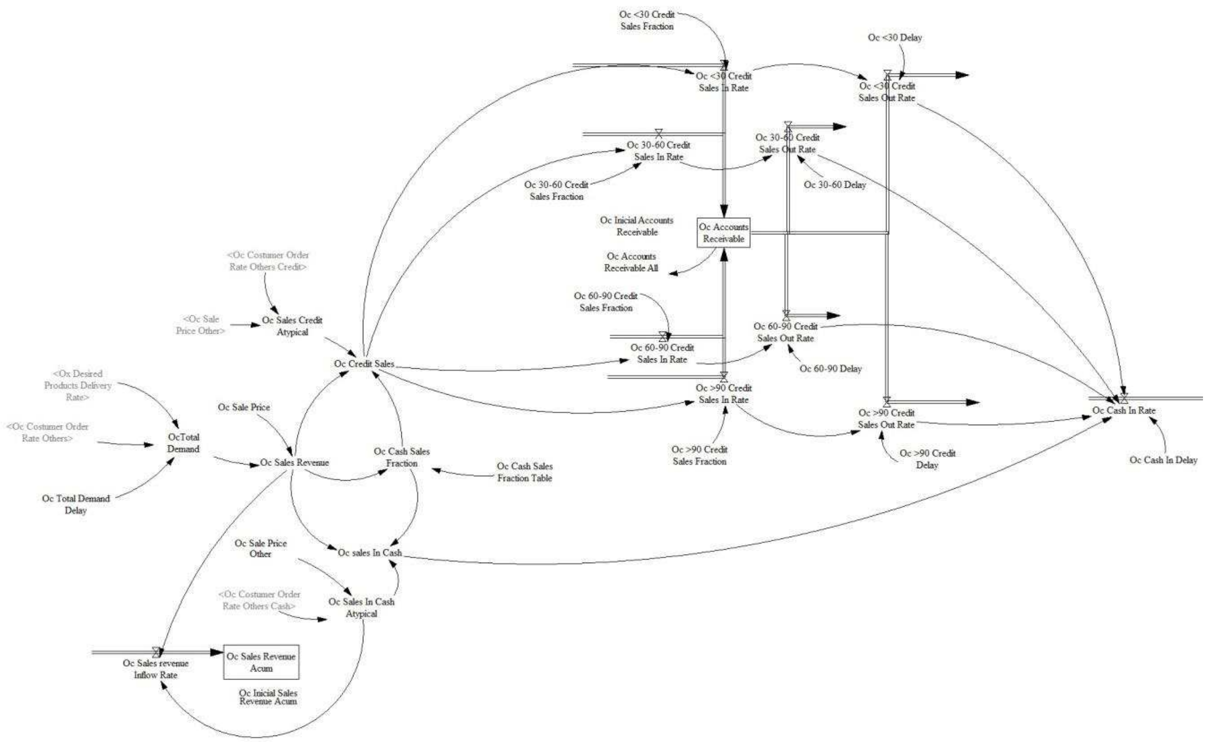

FIGURE 5. Payment accounts of manufacturing company.

2.3. Financial model of manufacturing company

Both models for each of the links are built from a generic model which incorporates the relevant policies of each logical link. The financial model for each of the links is presented in three sections those are payment accounts, accounts payable and cash flow.

(1). *Payment Accounts (O_c Account Income)*: Figure 5 corresponds to the payment accounts which are generated by credit from sales. Each reference has a different collection of policies. So, it is necessary to use previous data to calculate the patterns of these payments. Basically, the model depends on three key variables: O_c sales price, O_c total demand, O_c cash sales fraction. That means this model considers two situations. The first, sales are made entirely in cash; in this case, the total money raised from sales goes directly to the cash flow. The second situation arises when sales are made by credit. For this particular case, the company handles different terms from 30 to 90 days. Using previous information, it is calculated the probability that the sale made on credit will fall within a specified period.

(2). *Cash Flow (O_c Cash Flow)*: Figure 6 shows the payment accounts model. The level of the variable O_c cash flow in Figure 6 represents money that the company holds in cash in an instant of time. The 'cash flow' is influenced by two level variables: O_c owner savings buffer and O_c taxes payable. The first refers to a repository that stores money, unlike in the case of the distribution company; this repository can contain money from the bank or savings of the company and its shareholders. The level variable O_c taxes payable represents taxes which is filling this repository as sales revenues are generated and reduces the time that payments are made for national tax. These payments are made twice a year. Flow variable O_c cash in rate represents the flow of money coming into the distributor as result of reputable payment accounts and cash sales proceeds. Associated with this variable is a delay that is inherent in the administrative process.

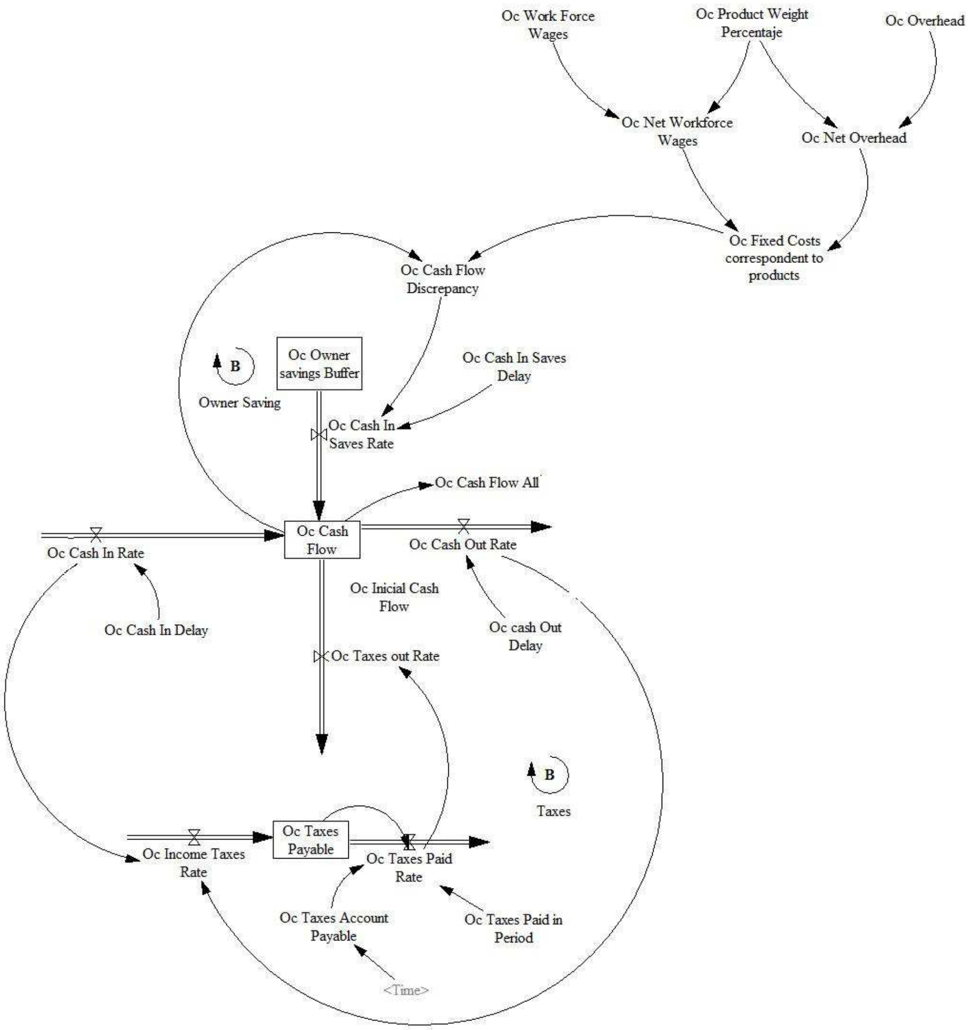

FIGURE 6. Cash flow of manufacturing company.

Variable O_c cash out rate represents the flow of money out of the company because of payment to suppliers and other payment inherent in its business, financial and administrative commitments. Delay is associated with this variable that happens during the administrative process.

(3). *Payment Accounts (O_c Account Income)*: This section of the model (Fig. 7) belongs to the payment accounts generated as consideration for the purchase of raw materials. The variable of payment account O_c is the variable that accumulates the level of all the purchases made from credit providers which feed the variable O_c credit purchase rate and decreases with flow variable O_c rate payments, which represents the periodic payment of purchases made on credit. Variable O_c credit represents the proportion of sales made on credit. The model is shown below (Fig. 7).

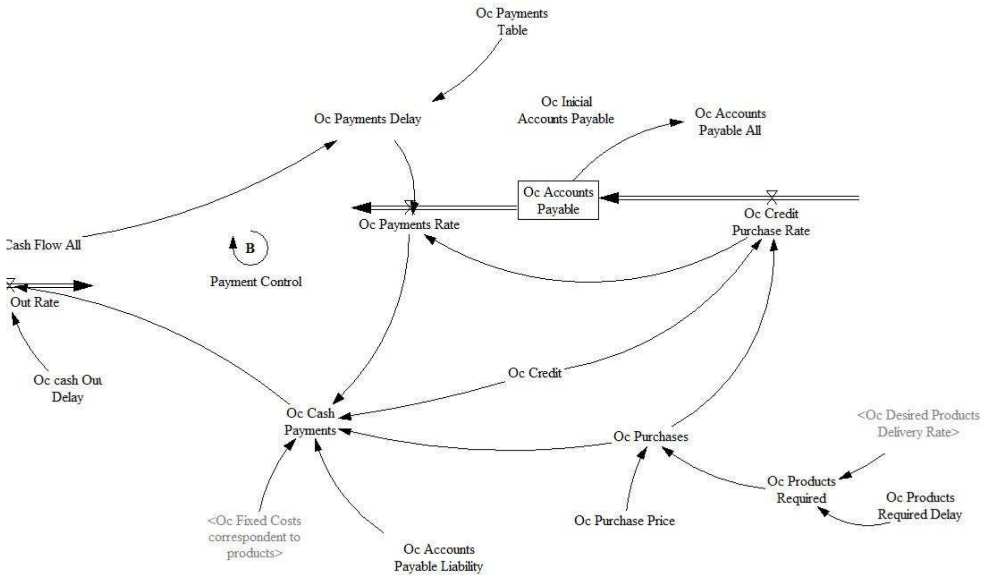

FIGURE 7. Payment accounts of manufacturing company.

2.4. Financial model of distributor

The financial model of the distribution company presents substantial changes with respect to the manufacturing company because they handle different policies for payment accounts and income accounts. As in the previous section, we will divide the model into three sections to study the structure in details.

(1). *Account income (O_x accounts income)*: This section of the model (Fig. 8) refers to accounts income, which are responsible for putting money to cash flow through credit sales or cash that has been canceled. Customers' order variable rate O_x is related to the inventory model that corresponds to the demand generated for the distribution company. This variable allows connecting both models (inventories and finance). Multiplying the variable O_x customer order rate by O_x sale price, the sales revenues are obtained which can be generated by cash or credit via the variable O_x cash sales fraction. The proceeds of cash sales go directly to the variable O_x cash flow while the remaining portion goes to the next step of the model to classify a sale, as the time period in which the payment will probably make these payments in short or long term. Likewise, every sale can be made with a credit or not. Then, this money of these branches eventually reaches to the repository of receivables. These payments come to cash flow due to a delay which is the time associated with the customer's late cash payment and the administrative delay in noticing this.

(2). *Cash flow (O_x cash flow)*: This part of the model (Fig. 9) is the point of concurrency of the payment accounts and accounts income. The level variable 'O_x cash flow' represents cash on hand at each time instant. Here are two-level variables: O_x owner savings and O_x taxes payable. The first refers to a repository that stores money which is a fund that has owned the company for use on occasions when it is required to pay any account or any costs and does not count on the money from the transaction, the fund is for potential use. The other flow variable corresponds to the taxes which are to be paid.

(3). *Payment accounts (O_x payment accounts)*: A significant variable of the financial model is the level of payment accounts O_x (Fig. 10). This variable accumulates money as a concept of debt that the company has with its suppliers. In this particular case, the maximum suppliers are the manufacturing companies in our same case study. The variable shipment rate O_x connects the inventory model of the manufacturing company to the financial model of the distribution company. Variable account payment O_x is associated with a set of policies that facilitates their independent study. The inputs of this model are the purchases

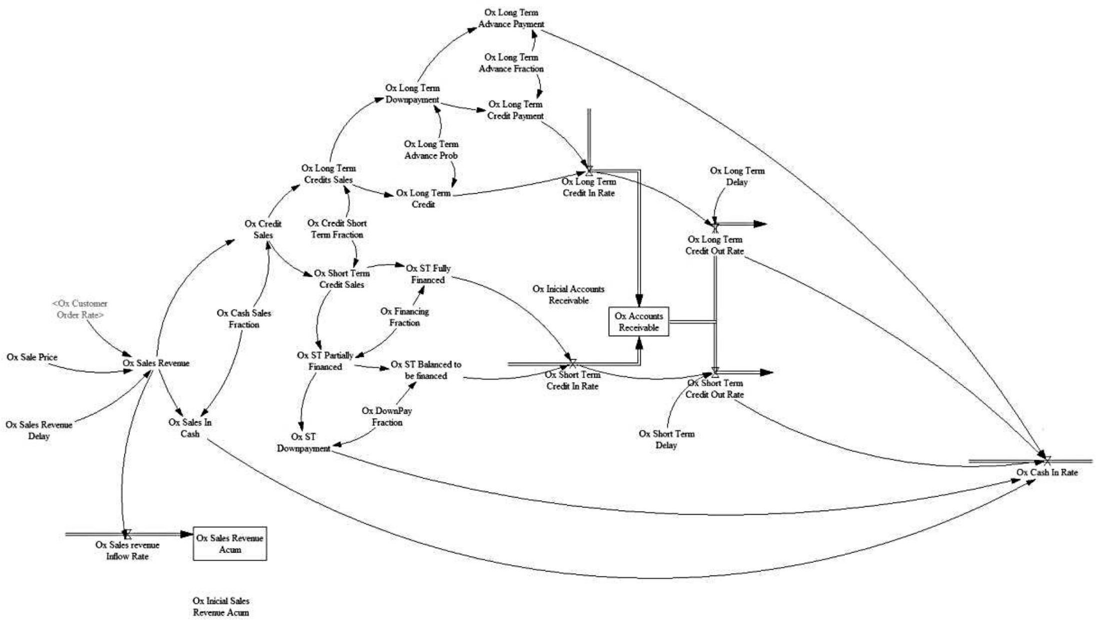

FIGURE 8. Accounts income of distributor.

that are made at the manufacturing company O_c. Particularly, account payments in these companies are not paid on time limits, but some are paid between 0 and 3 months, 3 and 4 months, 4 and 6 months and 6 to 8 months. So, it must be associated with a probability of occurrence to each of these events. In addition, each payment is associated with a table that determines how payments are made according to the availability of money in the account. This is done to ensure that the model attempts to delay payments in cases where there are no money in the repository. Delay is associated with each payment and the orders of these delays are calibrated. But, the average value of the delay is determined using data collected at the visits. In addition, there is an administrative delay with the administrative process of making a payment.

2.5. Cash to cash model

The metric C2C is defined as an integral measure of working capital. It is the interval of time between the purchases costs of raw materials to the cash received from the sales of the finished product. The cash to cash is important as it allows to set the time period in which a company must have sufficient working capital to settle accounts payments while receiving cash from sales of products and services. The decrease in this metric increases the net value of the cash flow as the company increases its liquidity. This increases usability and reduces costs by making it possible to carry out additional investments in current assets. It is also possible to make comparisons between companies in the same industry and find opportunities for improvement as well. The C2C consists mainly of three variables: inventory, account income and account payment. The model of the cash to cash is the same for both links as a way to differentiate between the two models where the former O_c abbreviations are used in the model variables of cash to cash for manufacturing firm (Fig. 11) and O_x to the distributor.

3. Model calibration

In this study, we shall only use the financial variables in order to calibrate the model, more specifically account income and account payment of both stages of the supply chain. The inventory variables will not be taken into

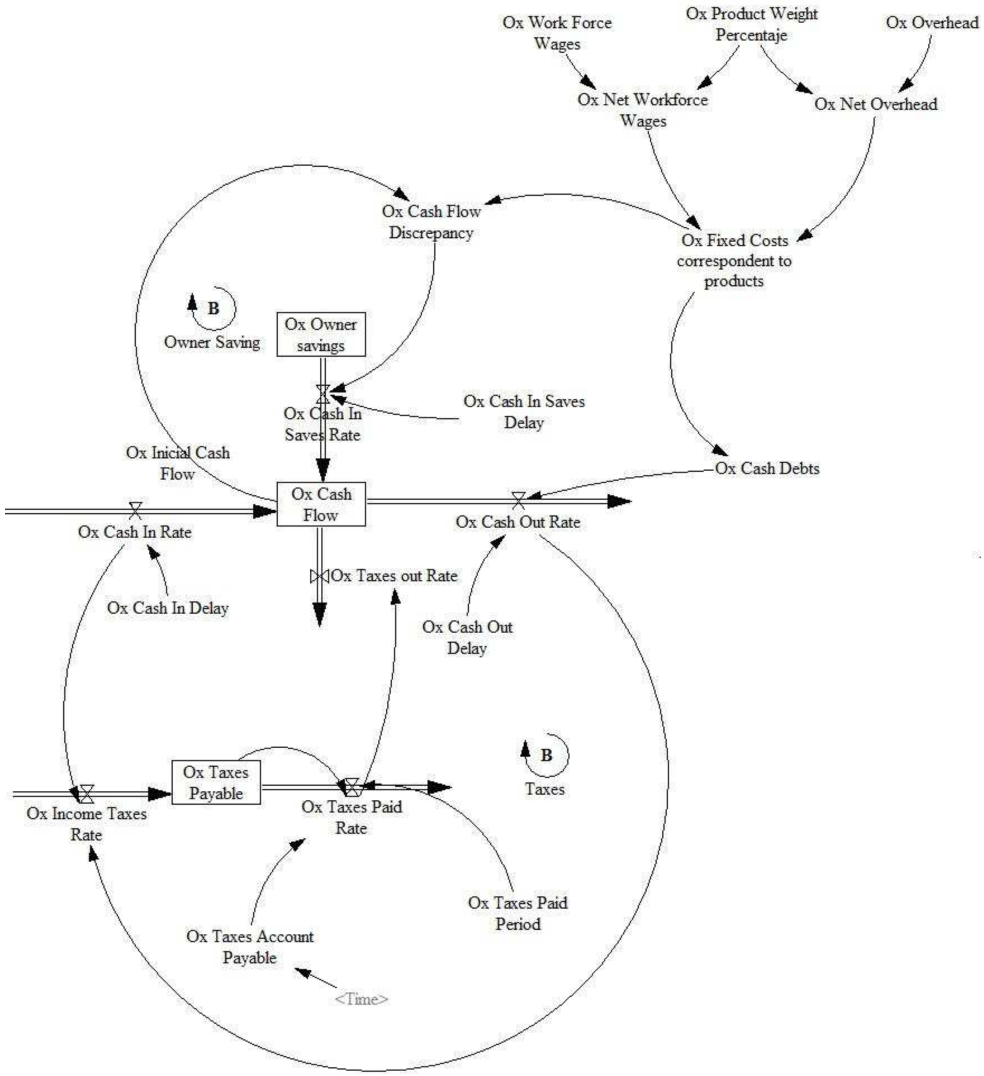

Figure 9. Cash flow of distributor.

account in the calibration because of the unreliability in the data. To perform this calibration, the Vensim's Optimizer which integrates an efficient Powell hill climbing algorithm [26] is used here. In this procedure, the modeler wants to calibrate a subset of (unknown) parameters so that the model behavior matches observed data. This may imply thousands of combinations of different values of parameters. Vensim calibration makes this procedure automatic, specifying it as a single optimization problem by minimizing an error function between simulated and actual matching output originated from a subset of fluctuating input data (Theil, 1979; Ventana Systems, Inc., 2014). Figures 12 and 13 show the sensitivity of inventories of manufacturer and distributor over varying time. Figures 14 and 15 show the manufacturers and distributors' matching series respectively. Both expose the actual behavior against simulated accounts payment and accounts income for each echelon. The purposes of generating these graphics are to visually determine the structural capacity of the model in order to replicate the data sets effectively.

Two tests for error measurement (see Tabs. 1 and 2), which are the traditional R^2 and a more accurate indicator of the nature of the setting such as the Theil's [33] inequality statistics are applied. The statistic R^2

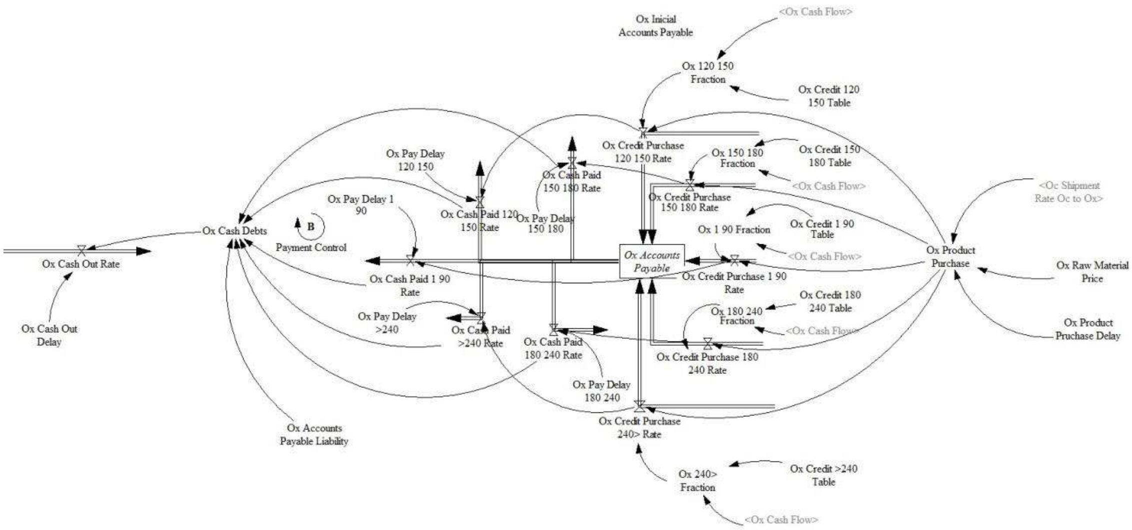

FIGURE 10. Accounts payment of distributor.

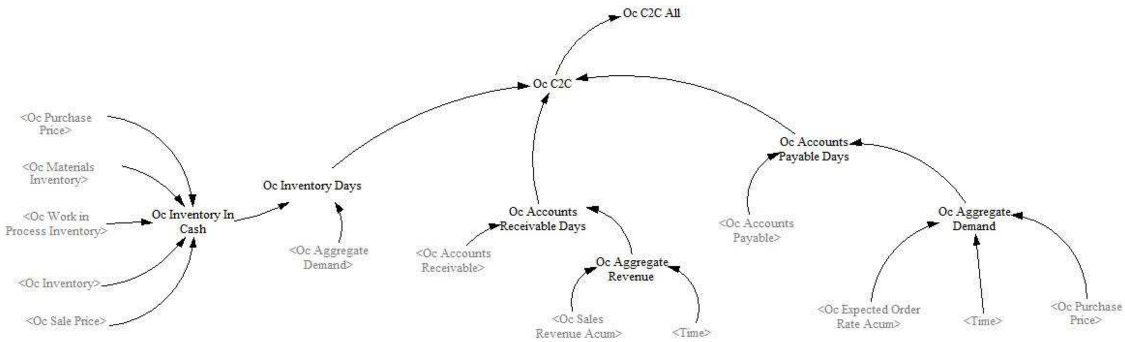

FIGURE 11. Cash to cash of manufacturing company.

generally shows the degree of fit with the real data. Theil's inequality statistics decomposes error into three components: bias (U_m), unequal variation (U_s), and unequal covariance (U_c). The bias (U_m) represents the difference between the means of the simulated and actual series. Hence, the goal is to reach a value as close to zero as possible. It determines the level of displacement of the central tendencies between the simulated and actual series. The unequal variation (U_s) deals with the extent to which the simulated series reproduces variations those are inherent to the real system variables. Lastly, the unequal covariance (U_c) contrasts autocorrelation of actual and simulated series. Since, it is unintended (not feasible) for an artificial signal to reproduce natural autocorrelation patterns which is desired to have the bulk of the error lying on this component.

The Theil's inequality analysis endorses the degree of fit that has a specific model when contrasts to its corresponding reality. However, to correctly diagnose the source of error in a calibration problem, it is necessary to explore the residual test [31]. A simple inspection of the residual plot varied over time is useful in detecting bias, trends and cyclical components [19] that might indicate violation of the construct assumptions. Furthermore, it is appropriate to study the feasibility of the rest of variables under extreme conditions in real system.

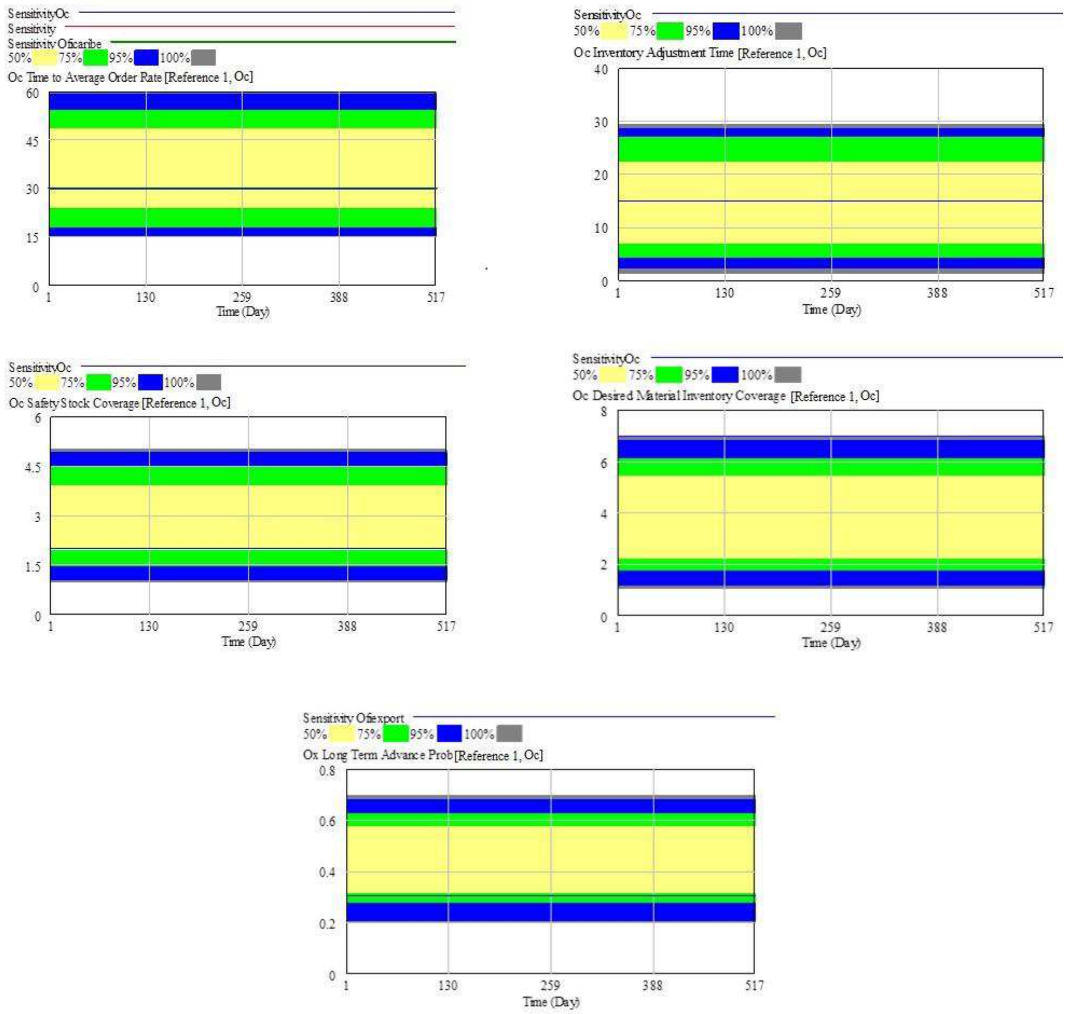

FIGURE 12. Sensitivity of variables [Reference 1, O_c] with varying time.

TABLE 1. Theil´s inequality statistics for the manufacturer calibration.

Theil's Inequality Statistics					
Product	Variable	R^2	U_m	U_s	U_c
Reference 1	Account receivable	0.93	0.00045	0.30	0.69
	Account payable	0.75	0.0015	0.084	0.92
Reference 2	Account receivable	0.82	0.080	0.31	0.60
	Account payable	0.48	0.059	0.00083	0.94
Reference 3	Account receivable	0.75	0.0058	0.078	0.91
	Account payable	0.66	0.065	0.047	0.88

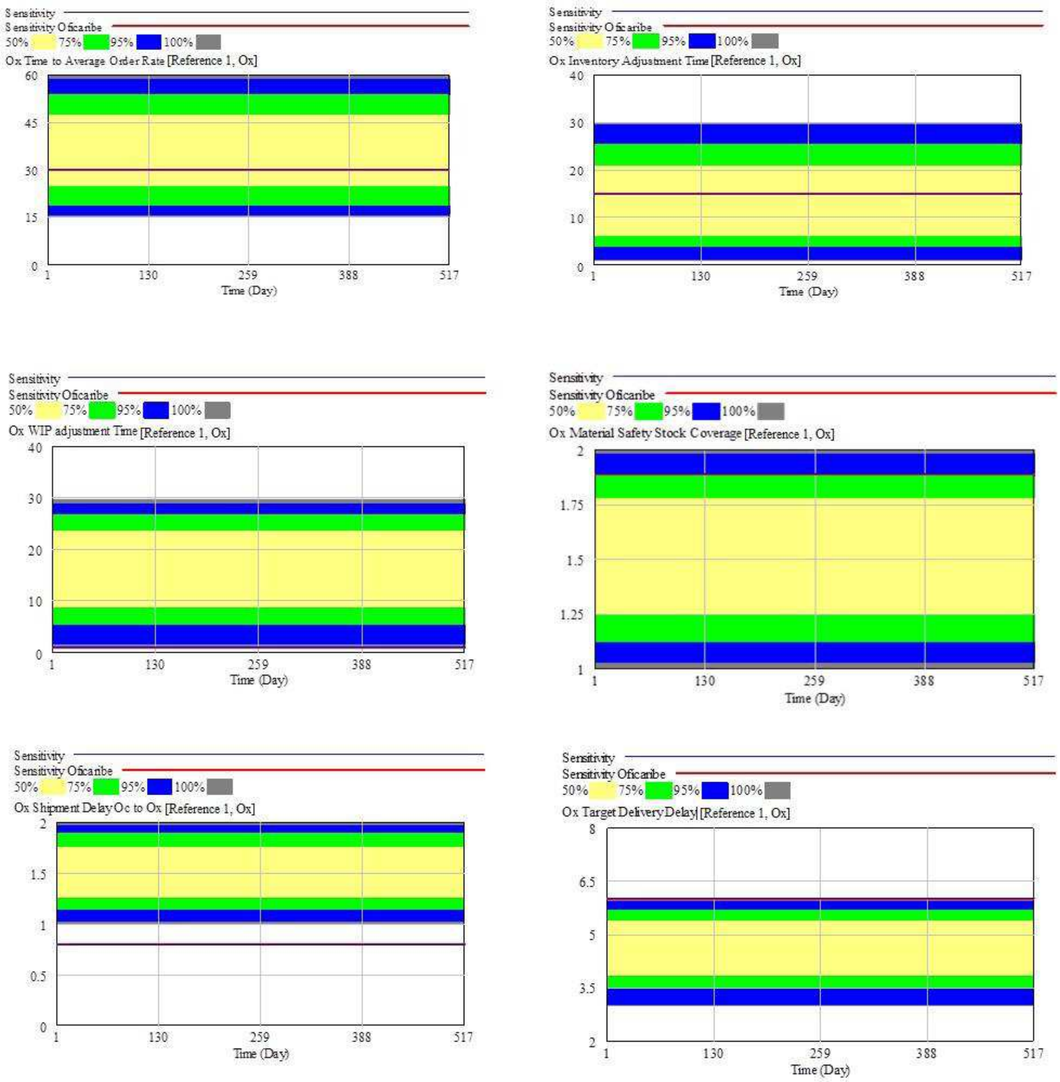

FIGURE 13. Sensitivity of variables [Reference 1, O_x] with varying time.

TABLE 2. Theil´s inequality statistics for the distributor calibration.

Theil's Inequality Statistics					
Product	Variable	R^2	U_m	U_s	U_c
Reference 1	Account receivable	0.78	0.0012	0.052	0.94
	Account payable	0.78	0.0012	0.052	0.94
Reference 2	Account receivable	0.57	0.0000057	0.13	0.86
	Account payable	0.87	0.0012	0.093	0.89
Reference 3	Account receivable	0.46	0.2	0.13	0.66
	Acco able	0.91	0.0000048	0.021	0.98

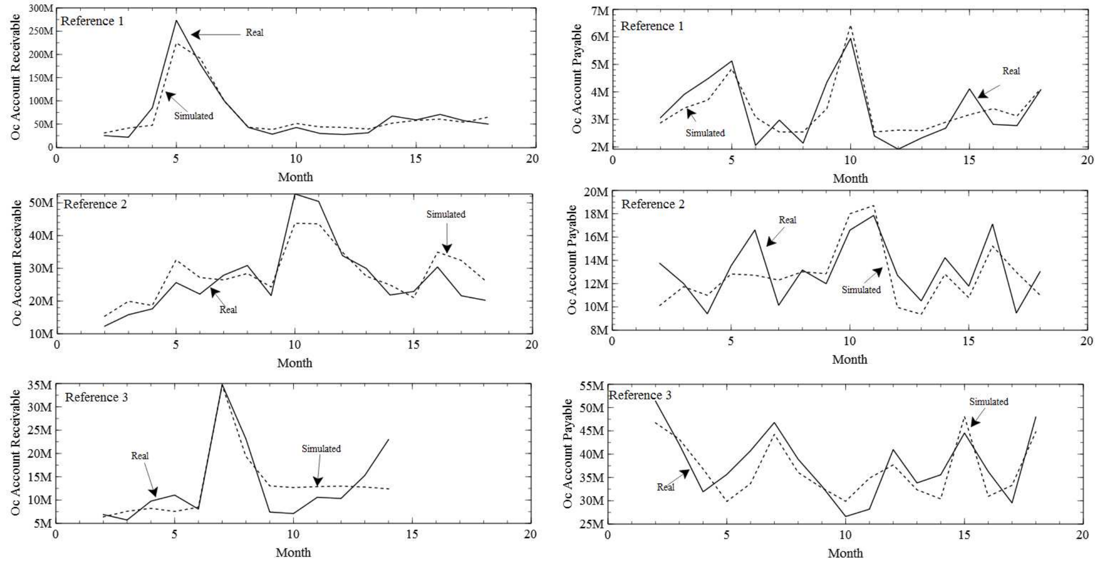

FIGURE 14. Calibration of manufacturing company.

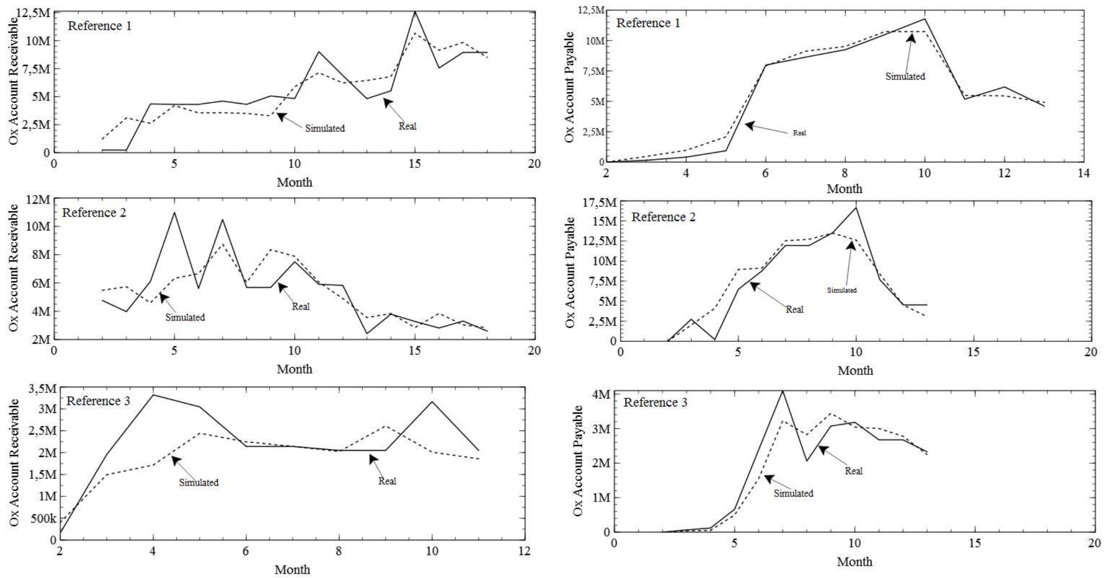

FIGURE 15. Calibration of distributor.

3.1. Optimization

Vensim Optimizer can search a large space of different values that can take into account the defined parameters in the sensitivity analysis (see Figs. 12 and 13). This optimizer does not have a limited number of known searches for optimal values as payoff. Therefore, optimizations are not stopped until these values can no longer be outperformed by the simulations. Optimizations are designed functions with response variables. Now, the following optimization functions are specified:

1. Minimize C2C function.

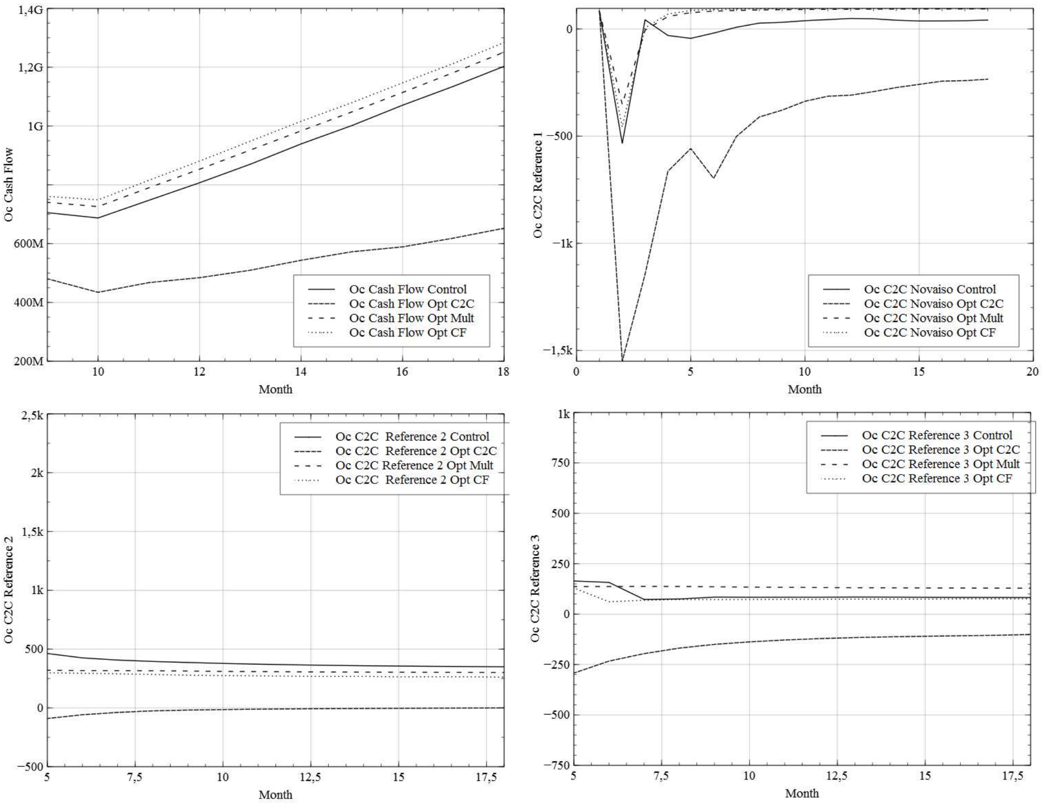

FIGURE 16. Optimization of manufacturing company.

TABLE 3. Optimization scenario's coding.

Code	Meaning
Control	Baseline scenario
OptMult	Joint C2C and Cash flow optimization
	cash flow optimization
OptC2C	C2C optimization
OptCF	Cash flow optimization

2. Maximize cash flow function.
3. Multi-objective optimization: minimize C2C and maximize cash flow.

It is useful to create an encoding for each of the scenarios and also for the current stage of the supply chain which is shown as below (Tab. 3).

Figure 16 shows optimization results for the Manufacturer, reflecting the optimized series of overall cash flow (O_c cash flow) and the C2C results for each of the products (C2C Reference i, $i = 1, \ldots, 3$) under the previously specified optimization settings. In general, these show the cumulative patterns of results in time, and the final results (in time) are the matter of the problem. It should be noted that a higher curve for the cash flow means superior results, as the smaller value of C2C is better. From the series (Fig. 17), it can be inferred that the optimization of cash flow (O_c cash flow Opt CF) is the one with best results in financial terms, because it improves substantially both the cash flow of the supply chain and the C2C metric for the flagship product (Reference 1). It enhances the C2C metric for the other two products, although these are not their best scenarios. Because, the bids affect the entire C2C supply chain as the income accounts take longer over

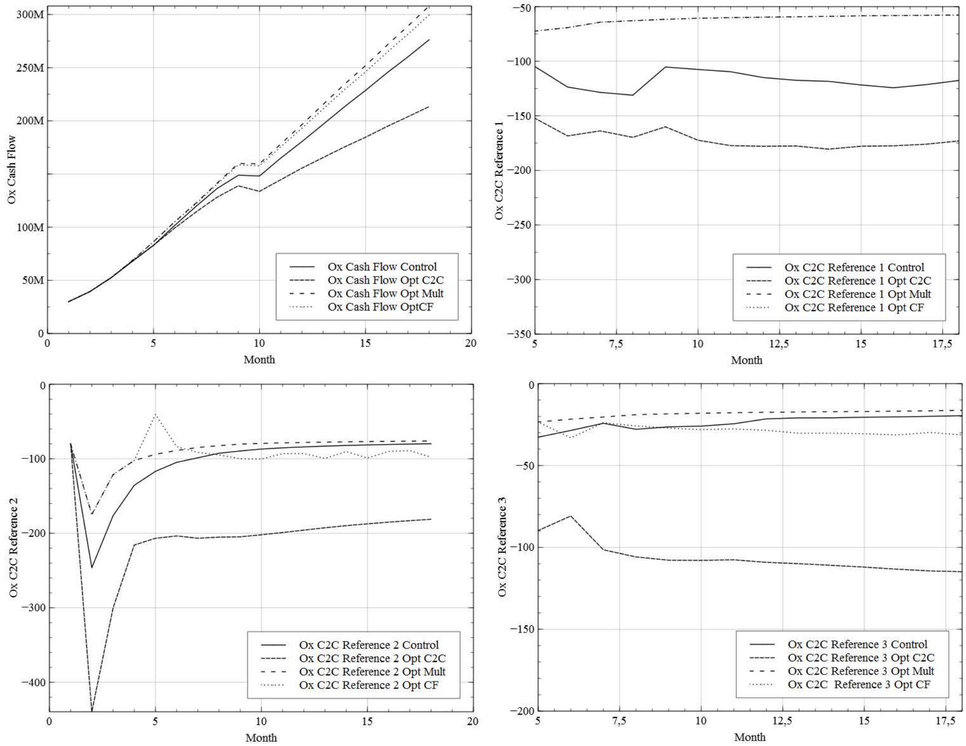

FIGURE 17. Optimization of distribution company.

TABLE 4. Supply chain parameter configuration.

#	Variables	Real	Adjustment	Interpretation
1	O_x Time to average order rate [products, Ofiexport]	30	15	More frequent forecasts
2	O_x Inventory adjustment time [products, Ofiexport]	15	7	Inspect more regularly
3	O_x Target delivery delay [products, Ofiexport]	6	3,6	Reduce lead time
4	O_c Time to average order rate [products, costumer]	30	60	Less frequent forecasts
5	O_c Inventory adjustment time [products, costumer]	15	30	Inspect with less regularly
6	O_c Safety stock coverage [products, costumer]	2	1	Reduce level of the safety stock
7	O_c Desired material inventory coverage [products, costumer]	7	3	Reduce level of the safety stock
8	O_c Material inventory adjustment time [products, costumer]	4	5	Inspect with less regularly
9	O_x Long term advance prob [products, Ofiexport]	0.3	0.7	Increase bids

time than the average sales accounts. For the distributor regarding the response variable O_x cash flow, the two optimization scenarios that represent a substantial improvement in O_x cash flow (cash flow) are OptCf and OptMult. Conversely, a significant decrease is noted in the cash flow of the company with the OptC2C.

The Opt C2C scenario improves the C2C metric for all references. Though it reduces the cash flow of the company, it is discarded as an overall optimal scenario. On the other hand, OptMult improves substantially the cash flow of the company. However, hurting the C2C metric for reference 1, it remains acceptable in any case. This means that we compromise the C2C metric of one reference to improve the overall cash flow and profit, and take the OptMult as the best for this company.

3.2. Policies and suggestion for improvement

Table 4 illustrates the parameter settings which are obtained from a run of optimization function using cash flow (O_c cash flow, OptCF). A qualitative interpretation of measurement associated with the change proposed by the model is as follows (Tab. 4).

After analyzing the model and its results, the following opportunities for improvements are proposed:

1. *Quantitative forecasts*: the manufacturing company should apply a cyclic forecast because the former demand for the company follows seasonal patterns with large volumes at certain time of year. Thus, it is recommended to implement a method of forecasting cyclical periods where revisions are made every 60 days. The distribution company, which is constantly growing, is advised to apply the method of double exponential smoothing which is a technique for forecasting time series used in cases in which the variable to forecast shows some tendency. This case presents an increasing demand so that the review is conducted every 15 days.
2. *Implementation of inventory policies and investment in technology*: the implement proposal for the manufacturing company is an MRP (material requirement planning) which allows to plan production and manage inventories of raw materials, sub- assemblies and finished products combined together with an MLM (logistic material management) [5] which seeks a balance between five objectives: 1. monitor performance in customer service, 2. reduction of inventories, 3. reduction of variability, 4. minimization of the total operating costs, 5. quality control of the product. For the distribution company, it is recommended to implement a periodic review of inventory at checkpoint R^2 (7 days).
3. *Increased participation in tenders*: When improvement policies are applied, the distribution company has a larger initiative to participate in a greater number and amount of bids with the state. Then, the supply chain will be ready to respond to an increase in demand.

4. Concluding remarks and future research

During the course of the investigation, it is concluded that a day is too limiting for understanding the high complexity of the financial systems. Therefore, it is necessary to expand the boundaries of the system in order to take into account both customers and suppliers who may shape behaviors that affect market demand and prices in both purchases and sales. The subscripts simulation becomes too complex and removes flexibility from the model. In future research, the boundaries of the model behavior could be expanded; including both providers and clients are endogenous and not exogenous as proposed in this paper. This would lead to a more realistic financial behavioral flow and physical flow in the companies. This work would be interesting by incorporating pull systems or mixed systems in order to evaluate the financial flow and so forth.

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