Proceedings of the Hamburg International Conference of Logistics (HICL) – 27

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HICL

Published in: Artificial Intelligence and Digital Transformation in Supply Chain Management
Wolfgang Kersten, Thorsten Blecker and Christian M. Ringle (Eds.)
September 2019, epubli

A Quantitative Assessment of the Collaborative Logistics Benefits

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Purpose: The purpose of this analysis is to study the Collaborative Logistics process, its implementation within the Consumer Electronics and Household Appliances Supply Chain and to assess the benefits stemming from it.

Methodology: To achieve the objectives the Activity-Based-Cost logic has been used. Each single defined activity has been associated to its most appropriate cost drivers. Moreover, an analytic simulation model has been built and implemented through a simplified representation of the Supply Chain composed of three actors: a retailer, a logistics operator and a manufacturer.

Findings: The benefits stemming from the Collaborative Logistics project are equal to 35.51%. The majority of Supply Chain benefits comes from the reduction in Stock-Out costs and Inventory Management costs.

Originality: The analytical model has been developed to foster the diffusion of this process by showing the potential benefits achievable through its implementation.

Keywords: eSupply Chain Collaboration, Collaborative Logistics, Consumer Electronics and Household Appliances Industry, Digitalisation

First received: 22.May.2019 **Revised:** 12.June.2019 **Accepted:** 17.June.2019

1 Introduction

In recent years, the adoption of innovative technologies in Supply Chain Management is accelerating faster and faster, changing the competitive paradigm. The needs of the final customers are getting more sophisticated, and this drives the companies to develop innovative products in ever-shorter time at affordable prices. To deal with these market changes, companies could implement collaborative projects both upstream and downstream in the Supply Chain, creating a competitive advantage. Indeed, these projects enhance the efficiency and effectiveness, such as production or inventory costs reduction and service level improvement. In particular, the Italian Consumer Electronics and Household Appliances Industry is characterised by a heterogeneous product portfolio and a wide product variety in terms of value and size. In the Italian market the most of companies are small and medium enterprises, the Supply Chain is rather concentrated in the upstream levels and extremely fragmented at the retail channel level. On the one hand, this complexity represented an initial barrier to establish collaboration among all the partners; on the other hand, the implementation of innovative technologies was necessary to create a competitive advantage. In this industry the use of e-Supply Chain Collaboration solutions is still sporadic: Consignment Stock between Manufacturers and Suppliers, Continuous Replenishment Programs (CRP) and after-sales support solutions between Manufacturers and Retailers are the most common. Recently, new collaborative processes have been emerged, such as the Collaborative Logistics project, able to centralise in a unique digital solution strategic and operational information in order to better integrate the actors of the chain. Based on these new technologies, there is room for improvement both in the efficiency and in the effectiveness of logistics activities (Cervello and Triventi, 2018).

The paper is organised as follows: the literature review presents evidence from the extant knowledge, the research questions and methodology defines the research questions and describes the adopted methodology, the findings section introduces the results, and conclusions and further development summarise the contribution and limitations of the model which can be addressed through future works.

2 Literature review

In the current scenario of the digital economy, the use of Internet can be a key factor for the enhancement of the Supply Chain Management (SCM) (Tan et al., 2002), thanks to the exchange of the information in real time and to the launch of collaborative project between the different business partners, thus creating the e-Supply Chain Management (e-SCM) (Gimenez and Ramalhinho, 2004). An e-Supply Chain can be described as a strategy of business where the e-commerce helps to optimise the processes, reduce the time production, give a faster and efficient response to the final customers (Luo et al., 2001). The advantage of the internet is that it allows the integration of the various systems of the different actors of a specific supply chain (Braglia and Frosolini, 2014), but the enterprise needs to invest a lot of resources, management commitment (as well as the commitment of the partners), time and energy and to handle the organizational changes to obtain real benefits from such solution (Pant et al., 2003).

With the adoption of integrated system within the organisation, companies could achieve different benefits such as: the developing of a cooperative business climate and an interactive approach to the supply chain, the capacity to foresee and react to demand fluctuation, and to improve the relationship between the actors of the supply chain and the consequent creation of strategic partnership (Luo et al., 2001). Other types of benefits are: the optimization of the internal and external operations, the response to the market in real-time (Pant et al., 2003), the cost savings (due, for examples, to the reduction of inventory level, procurement costs, and cycle time) and the increasing in the profitability (Akyuz and Rehan, 2009).

In this context, even the notion of the Supply Chain Collaboration (SCC) has gained the attention of many authors. The Supply Chain Collaboration arises when two or more firms share the responsibility of exchanging common planning, management, execution, and performance measurement information (Anthony, 2000) in order to accomplish a "synchronized Supply Chain" (Anderson and Lee, 1999). The reason is that integration with Supply Chain partners is needed to provide a value-add for the clients, with a consequent increase in satisfaction level and sales (Cao and Zhang, 2011). Moreover, thanks to the agreements with partners, a company can increase efficiency, reducing wastes, decreasing costs and achieving in this way a potential continuous flow (Narus end Anderson, 1995). Furthermore, partners have realised that they could extend the collaboration agreement to different activities with the purpose of enlarging the efficiency and the effectiveness of their processes and that the advancement in technologies have helped to deal with different activities, which imply the communication with partners (Cascio and Montealegre, 2016). Thanks to technological improvements partners have increased the quality and the type of information to exchange and have been able to extend the relationship with partners over different types of inter-organizational processes (Cao and Zhang, 2011). One of these projects is the Collaborative Logistics that builds on the existing relationship between trading partners (Manufacturers and Retailers) by extending this relationship to one or more service providers (Logistics Operators), act as the collaborative “hub” with their logistics base (Kaveh and Khosravi Samani, 2009). The Collaborative Logistics process can decrease the costs, and increase supply chain efficiency, in addition to make trading partners more flexible to manage the consumer demand fluctuation (Kaveh and Khosravi Samani, 2009).

The adoption of this solution is taking attention in the Italian Consumer Electronics and Household Appliances Supply Chain (eInvoicing & eCommerce B2b Observatory, 2018), and in the literature there is a lack of analysis regarding the benefits derived from the sharing of forecasting data stemming from the exchange of information between manufacturers, logistics operators and specialised retailers, enabled by the ICT-driven in the order-to-payment cycle integration (Cervello and Triventi, 2018). In fact, the communication of such data increases the visibility of each actor along the entire Consumer Electronics and Household Appliances Supply Chain (Cervello and Triventi, 2018).

3 Research questions and methodology

Given the identified gap, this paper attempts to contribute to the extant literature by proposing a model that aims at identifying which activities are involved into the implementation of a Collaborative Logistics project, how the processes change with respect to the traditional approach and how the adoption of this new approach can generate benefits for all the actors in the Supply Chain.

To reach this objective, the following research questions were identified:

RQ1: *How is the Collaborative Logistics project performed? What are the involved activities and the benefits stemming from its implementation? How can their costs be modelled?*

RQ2: *What are the benefits of adopting Collaborative Logistics in the Consumer Electronics & Household Appliances industry and how are they distributed among the triad of actors (i.e. Manufacturer, Retailer and Logistics Operator)? What are the benefits for the entire Supply Chain?*

The employed methodology encompasses specific activities, belonging to two different phases. The first step is characterised by the empirical analysis. It aims at defining the Collaborative Logistics model. In particular, 56 potential companies have been initially contacted. Finally, 12 out of 56 companies (4 Retailers, 4 Manufacturers and 4 Logistics Operators) have been selected, basing of the level of digitalisation and the role in the Supply Chain, and the implementation of the specific project we analysed to gather information through the interview. Thus, this phase was represented by the description of the process and the identification of all the activities performed by different actors. In particular, two different scenarios have been studied: AS-WAS, before the adoption of the Collaborative Logistics project; AS-IS, after the adoption of the Collaborative Logistics project. In the second phase, the model has been structured from an analytic perspective, in order to quantify the benefits coming from the adoption of a Logistics Collaborative project, through the Activity Based Methodology. The benefits have been computed with respect to three actors: Retailer, Manufacturer and Logistics Operator. Furthermore, the benefits of the overall Supply Chain have been quantified. Five differential costs elements between the two scenarios have been considered: Administrative costs, Inventory Management costs, Stock-Out costs, Penalty costs and Transportation costs. The simulation has taken into account a simplified Supply Chain made up of three companies. It was performed through Excel.

3.1 General hypotheses

The model represents a simplified representation of the reality, some general hypotheses need to be formulated. The hypotheses of the model try to be as adherent to reality as possible, so that the generated output can give companies trustful insights.

The cost modelling is based on two categories of hypotheses:

- The Demand profile;
- Inventory management.

With reference to the time, a time horizon equal to one year is applied, considering 52 weeks. Furthermore, in the simulation a time bucket of one week is used. The demand presents a strong seasonality, on the basis of what emerged from Statista website, filtering the Italian Household Appliances and Consumer Electronics sector in the year 2017. In particular, the Seasonality Index (S.I.) – for what concerns the demand seen by the retailer - is equal to the ratio between the actual monthly demand (Dt) and the average monthly one (μ_D) (equation 1). The demand follows a standard normal distribution and the considered variables are independent one to each other. The seasonality of the demand profile influences the computation of all the parameters and the variables (equations 2, 3, 4 and 5). The Table 1 lists all the variables of the seasonality index.

Table 1: Demand seasonality components

Variable	Description	Unit of measure	Source
$\boldsymbol{S.I._t}$	Seasonality index	–	Formula result
$\boldsymbol{D_t}$	Demand of the week t	[items]	Simulation computation
$\boldsymbol{D_{t;T+LT}}$	Demand over the Replenishment Period and the Replenishment Lead Time of the *week t*	[items]	Simulation computation
$\boldsymbol{SS_{t;T+LT}}$	Safety Stock facing the Demand and Lead Time Variability	[items]	Simulation computation

Variable	Description	Unit of measure	Source
	over the Replenishment Period and the Replenishment Lead Time of the *week t*		
$\boldsymbol{AT_t}$	Maximum Inventory Level for the *week t*	[items]	Formula results

Below, all the formulas are reported:

$$S.I._t = \frac{D_t}{\mu_D} \tag{1}$$

$$D_t = (\mu_D + z_t \cdot \sigma_D) \cdot S.I._t \qquad with\ z_t \sim N(0;1) \tag{2}$$

$$D_{t;T+LT} = \mu_D \cdot (T + LT) \cdot S.I._t \tag{3}$$

$$SS_{t;T+LT} = k \cdot \left(\sqrt{(T+LT) \cdot \sigma_D^2 + \mu_D{}^2 \cdot \sigma_{LT}^2}\right) \cdot S.I._t \tag{4}$$

$$AT_t = D_{t;T+LT} + SS_{t;T+LT} \tag{5}$$

This implies that the inventory level is not “static” but adherent to the real demand trend. The Retailer demand does not change from the AS-WAS to the AS-IS situation because it is always influenced by the variability of the final customer, so the collaboration or the technology used do not influence it. Instead upstream, the Manufacturer in the AS-WAS faces the variability both of the final customer and the Retailer. The Manufacturer demand forecasting is less accurate than the Retailer one because it is influenced by a “double” variability: that of the Retailer and that of the final consumer. Historical data do not come solely from the Manufacturer, but also by the Retailer. This affect all the subsequent activities of the model, including the production planning and the inventory management. The huge variability is smoothed in the AS-IS because it comes only by the final customer thanks to the visibility ensured by the platform.

The inventory planning model chosen is the Periodic Review. The orders are placed every T (Time, order interval) that in the simulation is equal to one week, both for the Manufacturer and the Retailer. The implementation of a fixed replenishment time period requires the existence of an Availability Target (AT) to be reached and a variable purchasing quantity (Q_t) which is computed on the basis of the inventory level (IL_t) (equation 6).

The availability target (AT) (equation 7) takes into consideration both the average demand, during the fixed replenishment period (T) and the replenishment lead time (LT), and the demand variability taken into account with the safety stock (SS).

In particular, the average demand (D_{T+LT}) (equation 8) and the safety stocks (SS_{T+LT}) (equation 9) are computed as.

In the Table 2 below all the variables of the inventory level componenets are described.

Table 2: Inventory level components

Variable	**Description**	**Unit of measure**	**Source**
T	Fixed Replenishment Period	[weeks]	Interviews
LT	Replenishment Lead Time	[weeks]	Interviews
Q_t	Purchasing Quantity	[items]	Formula result
AT	Availability Target	[items]	Formula result
IL_t	Inventory Level	[items]	Simulation computation
D_{T+LT}	Average Demand over the Replenishment	[items]	Simulation computation

Variable	Description	Unit of measure	Source
	Period and the Replenishment Lead Time		
SS_{T+LT}	Safety Stock facing the Demand and Lead Time Variability over the Replenishment Period and the Replenishment Lead Time	[items]	Simulation computation
μ_D	Average Weekly Demand	[items/weeks]	Simulation computation
k	Function of the Service Level	–	Simulation computation
σ_D^2	Demand Variance	$[\text{items}^2]$	Hypothesis
σ_{LT}^2	Lead Time Variance	$[\text{weeks}^2]$	Hypothesis

Below, all the formulas concerning the inventory level are reported:

$$Q_t = AT - IL_t \tag{6}$$

$$AT = D_{T+LT} + SS_{T+LT} \tag{7}$$

$$D_{T+LT} = \mu_D \cdot (T + LT) \tag{8}$$

$$SS_{T+LT} = k \cdot \sqrt{(T + LT) \cdot \sigma_D^2 + \mu_D{}^2 \cdot \sigma_{LT}^2} \tag{9}$$

Obviously, different demands are considered with respect to different classes. The Stock Keeping Units (SKUs) are divided into three classes (see Table 3 for details) on the bases of the inventory turnover index, collected in Statista website. Class A is made by the high-rotating SKUs, class B by the medium-rotating and class C by the low-rotating. The assignment of the SKUs to the classes follows the marginal increase methodology. This items classification holds true for both the Retailer and the Manufacturer.

Table 3: Division in classes

Classes	**Items**	**Volume**
Class A	1%	50%
Class B	50%	40%

Classes	Items	Volume
Class C	49%	10%

3.2 Cost modelling

After the definition of the general hypotheses, the cost structure has been modelled so that all the costs drivers are included.

The costs categories considered within the simulation are:

- Administrative costs;
- Inventory management costs;
- Stock-out costs;
- Transportation costs;
- Penalty costs.

Table 4: Cost categories for each actor

	Adminis-trative Costs	Inventory Management Costs	Stock Out Costs	Trans-porta-tion Costs	Pen-alty Costs
Manu-facturer	Impacted	Impacted	Im-pacted	Not-im-pacted	Im-pacted

	Administrative Costs	**Inventory Management Costs**	**Stock Out Costs**	**Transportation Costs**	**Penalty Costs**
Logistics Operator	Impacted	Not-impacted	Not-impacted	Impacted	Impacted
Retailer	Impacted	Impacted	Impacted	Impacted	Not-impacted
Entire Supply Chain	Impacted	Impacted	Impacted	Impacted	Impacted

In Table 4, the categories considered for each actor and for the whole Supply Chain perspective are synthesized.

In order to distinguish the costs related to different actors, some indexes are used: “M” refers to the manufacturer, “R” to the retailer, “L” for the Logistics Operator. Moreover, as the items are divided in three classes, the subscript “i” is used to specify them and “t” refers to the time period (one week in this case).

The Supply Chain costs function (equation 10) is given by:

$$Total\ \ costs = \sum_{i=M,L} Penalty\ \ costs_i + \sum_{i=M,R}(Inventory\ \ management\ \ costs_i + \ Stock - out\ costs_i) + \sum_{i=R,L} Transportation\ \ costs_i + \sum_{i=M,R,L} Administrative\ \ costs_{i_i} \quad (10)$$

The Manufacturer costs function (equation 11) is given by:

$$Total\ costs = Penalty\ costs + Administrative\ costs + Inventory\ management\ costs + Stock - out\ costs \quad (11)$$

The Retailer costs function (equation 12) is equal to:

$$Total\ costs = Administrative\ costs + Transportation\ costs + Stock - out\ costs + Inventory\ management\ costs \quad (12)$$

The Logistics Operator costs function (equation 13) is given by:

$$Total\ costs = Administrative\ costs + \ Transportation\ costs + Penalty\ \ costs \quad (13)$$

For all the costs categories, all the formulas and the specifications are reported. For the administrative cost the main components are illustrated in the Table 5 and the related formulas in the equation 14.

Table 5: Administrative cost components

Variables	Description	Unit of measure	Source
$\boldsymbol{T_{proc}}$	Delivery Processing Time	[hour]	Interview
$\boldsymbol{c\ l_h}$	Administration Hourly Labor Cost	[€/hour]	https://www.fisco-etasse.com
$\boldsymbol{C_{paper}}$	Paper cost	[€/sheet]	eCommerce website
$\boldsymbol{sheets}$	Number of sheets per order	[sheet/order]	Hypothesis
$\boldsymbol{C_{space}}$	Space Occupation Cost	[€/m^3]	Hypothesis
$\boldsymbol{space_{sheets}}$	Space Occupied by Sheets	[m^3/sheet]	Hypothesis
$\boldsymbol{N_o}$	Number of deliveries per Week	[order/week]	Interview

$$\text{Administrative Cost} = \left[T_{proc} \cdot c\, l_h + C_{paper} \cdot \text{sheets} + C_{space} \cdot \text{space}_{sheets} \cdot \text{sheets}\right] \cdot N_o \quad (14)$$

For the inventory management cost, formula and components (as example are reported cost and components referring to the manufacturer case) are illustrated in the Table 6 and the related formulas in the equation 15, equation 16, and equation 17.

Table 6: Inventory management cost components

Variables	Description	Unit of measure	Source
r	Inventory Carrying Cost Rate	[€/(€*year)]	Financial website
$c_{u;M}$	Manufacturing Unitary Cost	[€/item]	Consumer Electronics and Household Appliances websites
k_M	Manufacturer Function of the Service Level	–	Simulation computation

Variables	Description	Unit of measure	Source
$\boldsymbol{CS_M}$	Manufacturer Average Cycle Stock	[items]	Formula result
$\boldsymbol{SS_M}$	Manufacturer Average Safety Stock	[items]	Formula result
$\boldsymbol{T_M}$	Manufacturer Fixed Replenishment Period	[weeks]	Hypothesis
$\boldsymbol{LT_M}$	Manufacturer Replenishment Lead Time	[weeks]	Interview
$\boldsymbol{\sigma_{D_{M;i}}}^2$	Manufacturer Demand Variance for the Product Class i	$[\mathrm{items}^2]$	Hypothesis
$\boldsymbol{\mu_{M;i}}$	Manufacturer Average Weekly Demand for the Product Class i	[items/weeks]	Interview

Variables	Description	Unit of measure	Source
$\boldsymbol{\sigma^2}_{\boldsymbol{LT;M}}$	Manufacturer Lead Time Variance	[weeks^2]	Hypothesis
$\boldsymbol{CS_{M;t;i}}$	Manufacturer Cycle Stock for the Product Class i in the week t	[items]	Formula result
$\boldsymbol{S.I._{M;t}}$	Manufacturer Seasonality Index of the week t	–	Formula result

$$Inventory\ Management\ Cost_M\ (\,IMC_M\,) = \ r \cdot c_{u;M} \cdot (CS_M + SS_M) \quad (15)$$

$$Avg.Safety\ Stock_M = \frac{k_M \cdot \sum_{t=1}^{52} \sum_{i=1}^{3} \left(\sqrt{(T_M + LT_M) \cdot \sigma_{D_{M;i}}{}^2 + \mu_{M;i}{}^2 \cdot \sigma^2{}_{LT;M}} \right) \cdot S.I._{M;t}}{52} \quad (16)$$

$$Average\ Cycle\ Stock_M\ (CS_M) = \frac{\sum_{t=1}^{52}\ \sum_{i=1}^{3} CS_{M;t;i} \cdot S.I._{M;t}}{52} \quad (17)$$

For the stock-out cost, formula and components (as example are reported cost and components referring to the manufacturer case) are illustrated in the Table 7 and the related formulas in the equation 18 and equation 19.

Table 7: Stock-out cost components

Variables	**Description**	**Unit of measure**	**Source**
SL_R	Retailer Service Level	[percentage]	Interview
$D_{R;\,yearly}$	Yearly Retailer Demand	[items]	Interview
$p_{u;\,R}$	Retailer Unit Price	[€/item]	Statista
$c_{u;\,R}$	Retailer Unit Cost	[€/item]	Simulation computation
SL_M	Manufacturer Service Level	[percentage]	Interview
$D_{M;\,yearly}$	Yearly Manufacturer Demand	[items]	Interview
$p_{u;\,M}$	Manufacturer Unit Price	[€/item]	Statista

Variables	Description	Unit of measure	Source
$c_{u;\,M}$	Manufacturer Unit Cost	[€/item]	Simulation computation

$$Stock - out\ costs_M = (1 - SL_M) \cdot D_{M;\,yearly} \cdot (p_{\,u;\,M} - c_{\,u;\,M}) \quad (18)$$

$$D_{M;\,yearly} = \sum_{t=1}^{52} \sum_{i=1}^{3} D_{R;\,t;\,i} \quad (19)$$

For the transportation cost, formula and components are illustrated in the Table 8 and the related formulas in the equation 20, equation 21, and equation 22 for the Retailer, and equation 23 for the Logistics Operator.

Table 8: Transportation cost components

Variables	Description	Unit of measure	Source
cl_h	Hourly haulers Labor Cost	[€/hour]	https://www.fisco-etasse.com
AS	Average Speed of Truck	[km/hour]	Ministero delle Infrastrutture e dei Trasporti

Variables	Description	Unit of measure	Source
l	Diesel liters consumed	liters	Simulation computation
$\#Deliveries$	Number of Deliveries	–	Simulation computation
ton	Weight of goods transported	ton	Simulation computation

For Retailer:

$$Tranportation\ costs = 0{,}75 \cdot Transportation\ share + 0{,}25 \cdot Diesel\ share \quad (20)$$

$$Transportation\ share_R = \#Deliveries \cdot \left[\sum_{t=1}^{52}\sum_{i=1}^{3}\frac{Km}{ton} \cdot \left(\frac{€}{km \cdot ton}\right)\right] \quad (21)$$

$$Diesel\ share = \frac{€}{l} \cdot \left(km \cdot \frac{l}{km}\right) \quad (22)$$

For Logistics Operator:

$$Transportation\ costs_L = \frac{Km}{AS} \cdot\ cl_h \quad (23)$$

Eventually, for the penalty cost, formula and components are illustrated in the Table 9 and the related formulas in the equation 24 and equation 25 for the Manufacturer, and equation 26 and equation 27 for the Logistics Operator.

Table 9: Penalty cost components

Variables	Description	Unit of measure	Source
$percentage\ of\ OTD$	Logistics Operator's On-Time-Delivery	[percentage]	Interview
0,2	Penalties Payed by the Logistics Operator in case of Consignments not Delivered on Time	[euro]	Hypothesis
0,2	Penalties Payed by the Manufacturer	[euro]	Hypothesis
$percentage\ of\ OTIF$	Manufacturer's On-Time-In-Full	[percentage]	Interview

Variables	Description	Unit of measure	Source
P_M	Purchase price paid by the Retailer to the Manufacturer	[euro]	Hypothesis

For Manufacturer:

$$Penalty\ Costs_M = \#Deliveries \cdot [(1 - percentage\ of OTIF) \cdot 0{,}2 \cdot P_M \tag{24}$$

$$OTIF\ (percetange) = \frac{number\ of\ deliveries\ OTIF}{total\ number\ of\ deliveries} \cdot 100 \tag{25}$$

For Logistics Operator:

$$Penalty\ costs_L = (1 - percentage\ of\ OTD) \cdot 0{,}2 \cdot Transportation\ costs_R \tag{26}$$

$$OTD = \frac{Orders\ delivered\ on\ time}{total\ orders\ shipped} \tag{27}$$

4 Findings

The Italian Consumer Electronics and Household Appliances Industry is characterised by high product variety and high fragmentation at the downstream side of the Supply Chain. This sector is attending the rising of a new collaborative model accessible via B2b Web Portals: Collaborative Logistics. The reason why this model is rising in the matter of Supply Chain Management is that this type of collaboration integrates in one single solution manufacturers, logistics operators and retailers operational and strategic information. This is possible since the technology supporting this program allows partners to quickly share data on a centralised platform, which enhances visibility on that specific information needed by partners. Moreover, the main technology used between manufacturers and their suppliers is B2b Portals for the development of automatic replenishment and Consignment Stock solutions.

Analysing more in depth the Collaborative Logistics project, the model description has the aim of analysing the logistics processes of Retailer, Manufacturer and Logistics Operator, identifying the main activities and understanding how they change when passing from the AS-WAS to the AS-IS scenario. In particular, the AS-WAS scenario considers the Supply Chain before the adoption of the Collaborative Logistics project. While the AS-IS scenario takes into consideration the process after the adoption of this solution. The process is divided into different phases. The first step for all the activities is the forecast of the annual demand. In the AS-WAS scenario, each actors of the chain made the forecast as a single entity, on the basis of the order history of the immediate customers. This creates great variability due to the information distortion. In the AS-IS model, the demand forecast is made in an aggregated way, given that each actor shares online information across the whole Supply Chain (including third Parties Logistics). Thanks to the new technology, it is possible to communicate and coordinate the demand and the production with the other players in the Supply Chain. This significantly reduces the variability and the inefficiencies, leading to a reduction of the total Supply Chain lead time. Another difference between the AS-WAS and AS-IS situation is the way in which the request for reservation of the delivery slot is made. The main functionality of the platform is the one related to the booking of delivery slots, made possible by sharing the agendas of the different depots. This phase changes very greatly in the two situations. The phases majorly impacted by the implementation of the collaborative model (in the AS-IS situation) and in particular by the technology are: creation of the appointment request, made by the Logistics Operator; management of the appointment request, made by the retailer. The technology on which the portal is based (e.g., a Cloud solution) optimizes this process by shortening booking times and thus speed up the physical delivery of goods. Therefore, by eliminating all traditional methods such as telephone/email, and any other means that can be used to send data in an unstructured format, it is possible to speed up the booking process downstream. Summarizing, the exploitation of the technology creates a single, shared platform accessible from every device, for an integrated management of inter-company processes: it supports a single standard method for managing bookings and, more generally, delivery activities through a shared tool within the entire Supply Chain for Household Appliances and Consumer Electronics industry.

The benefits of using the Collaborative Logistics portal are several and transversal for each category of users accessing the platform. The positive contribution of the platform is not limited to purely administrative activities (e.g., management of documentation related to the delivery process), but also has an impact on typically operational activities (e.g., loading/unloading of the vehicle). This project allows to improve both the supply side (efficiency) and the demand-side (effectiveness) issues. By combining these two elements, the project helps adjusting Supply Chain processes to better meet demand without neglecting efficiency. In addition, having identified a single standard and structured communication language enables better communication between the parties, which can be immediately understood and automated. The combination of these features allows to improve the efficiency and effectiveness of the process, thanks to a better quality of data (proven, for example, by the reduction of errors in data due to data entry) and a higher productivity of the resources used that can be freed from the execution of low value-added activities to devote themselves to other. The shared data allows to co-manage the customer and so creates implicitly a value for everyone.

In detail, the benefits for the Manufacturer related to the project implementation are the higher visibility on the products present at the Retailer PoS, with the opportunity to better program the internal operations to satisfy the retailer requirements and, if present, to incur in less penalties, the arrangement, with the other partners, of the quantities and the time windows of the deliveries in order to touch the goods as low times as possible, the optimization of the production planning, the increasing of orders frequency and accuracy and reduction of orders size, and the general reduction of logistics costs.

While the benefits for the Logistics Operator can be synthesised in the following way: the possibility to plan the delivery in advance, with a reduction of waiting time for loading at the depot and unloading at the Point of Sale, and the reduction of the number of trips, due to a major aggregation of different manufacturers.

The main benefits for the Retailer are, instead, the higher service level to the market, due to the certainty of delivery date from the Manufacturer, and the possibility of claiming about problems by using the online platform.

Finally, through the platform, it is also possible to monitor the performances by some Key Performance Indicators (KPIs).

Here are some examples: the appointment response: e.g., percentage of response, percentage of expired response, the degree of acceptance of Collaborative Logistics: e.g., percentage of acceptance, percentage of rejection, the exception monitoring: e.g., percentage of advances, number of reprogramming, and the monitoring deliveries (e.g., percentage of On-Time Deliveries).

According to the interviewed companies, different implementation barriers are present, such as: the internal organizational inertia to the change, for all the three considered actors, due to the employees' fear of moving on a new solution, very different from the traditional one. To overcome this barrier, is fundamental to involve all the human resources at any level and pass from a vertical organization to a transversal, cross-managed one, the necessity of educating the human resources to use the new technology, through a training program, with the aim of having skilled people, the Retailer resistance to stock and demand information sharing with the Manufacturer, and the difficulties in coordinating the logistics and the commercial functions.

4.1 Quantitative benefits

The cost structure has been modelled so that all the costs drivers are included in the simulation. The costs categories considered within the simulation are:

- Administrative costs;
- Inventory management costs;

- Stock-out costs;
- Transportation costs;
- Penalty costs.

Once the model has been initialised, it is possible to analyse the obtained results. The outputs refer to the benefits that each actor could achieve by adopting the Collaborative Logistics project.

The Manufacturer could achieve high benefits in implementing the Collaborative Logistics project. After its introduction, it faces a reduction of 11.25% in the total costs, which corresponds to an absolute value of € 5,880,787.24. In this way, it is easier to understand which the cost components are having the highest impact on the manufacturer benefits. The Inventory Management costs face the highest absolute variation from the AS-WAS to the AS-IS. However, the highest incidence value is covered by the Penalty costs. Consequently, even if their percentage variation is not the highest one (+25.16%), they have a huge effect on the total benefits due to their incidence on them (47.54% in the ASWAS and 67.05% in the AS-IS). On the opposite side, the Administrative costs have the biggest percentage variation (-93.07%) from the AS-WAS to the AS-IS situation, but they do not heavily affect the total benefits, as they cover a small portion of the total costs (0.48% in the AS-WAS and 0.04% in the AS-IS).

The Logistics Operator could achieve high benefits in implementing the Collaborative Logistics project equal to a reduction of 9.74% in the total costs, which corresponds to an absolute value of € 283,927.70. The reduction in the other costs leads to an overall benefit, even if the total costs reduction is the lowest compared to the Manufacturer and the Retailer. The costs undergoing the highest variations, thanks to the Collaborative Logistics project, are the Administrative costs. The percentage variation of the Transportation costs is -11.5%, they have a huge effect on the total benefits due to their incidence on them (60.71% in the AS-WAS and 59.54% in the AS-IS). Moreover, the Administrative costs have the biggest percentage variation (-72.39%) from the AS-WAS to the AS-IS situation, but they do not heavily affect the total benefits, as they cover a small portion of the total costs (7% in the AS-WAS and 2.4% in the AS-IS).

The Retailer benefits are the highest compared to the Manufacturer and Logistics Operator ones. The Retailer achieves a reduction in the total cost of -17.24%, corresponding to an absolute value of € 24,554,784.31. The costs undergoing the highest variations, thanks to the Collaborative Logistics project, are the Administrative and Stock-out costs. Moreover, the increase in the Inventory Management Costs is a consequence of the reduction of the bullwhip effect. The inventory benefits are not equally distributed among the Manufacturer and the Retailer; only the Retailer faces the avoidable costs of inventory management and, to make it accept the strategy, a costs' sharing assurance is required. The most impacting costs over the total benefits are the Transportation costs. The Transportation costs are reduced because there is an optimization of the trips that allows to saturate better the trucks and given that the number of trucks used is tied to the cost, consequently the total costs are reduced. Therefore, this high percent variation has a huge impact on the total benefits as the Transportation costs cover a big portion of them (75.88% in the AS-WAS and 80.01% in the AS-IS).

After having explained the benefits for each actor of the triad, it is fundamental to analyze the improvements under the entire Supply Chain perspective. Considering the Supply Chain as a whole, the benefits are still positive. In the AS-WAS situation, each player acted as an individual entity and, as it is clear from the data shown above, the goal of everyone was to minimize its own costs rather than the Supply Chain ones. The consequence was inefficiency due to higher Supply Chain costs, in particular, in terms of both Inventory and Stock-Out. There is a reduction of 35.51% in the total costs, which corresponds to an absolute value of € 23,686,761.21. The highest benefits for the Supply Chain come from the Stock Out Costs reduction (- € 12,210,000.00). In particular, the Transportation costs are composed by the Transportation share and the Diesel share, but since the Transportation share represents a cost for the Retailer and an income for the Logistics Operator, they are not differential considering the entire Supply Chain perspective. Moreover, the total Supply Chain Inventory Management costs mainly decrease because of the Manufacturer, this is due to the implementation of the PULL logic instead of the PUSH. Thanks to the collaboration, the inventories shift to the Retailer, enabling the chain to cope with the demand variation. This implies that one player in the Supply Chain bears more risks than the other players along the Supply Chain. As concerns the Administrative costs, they represent a very small part of the total costs, but they are the only ones that decrease for each of the three actors.

5 Conclusions and further development

This paper has the main aim to provide an effective practical tool for managers to understand the main benefits of the Collaborative Logistics project. The analytical model has been developed to foster the diffusion of this process by showing the potential benefits achievable through its implementation. Moreover, the impact for scholars is the analytical contributions, since there is a lack of quantitative assessment stemming from the Collaborative Logistics in the current literature. The work sheds light on a new process that is becoming more and more important in the Italian context and that has not been deeply studied by scholars yet.

Nevertheless, some limits are present. First of all, just three actors along the chain have been considered: Retailer, Manufacturer and Logistics Operator. An important hint for future researches could be to study the inclusion of other actors upstream, as an example the manufacturers' supplier. Furthermore, a simplification has been introduced within the analytical model: only a one-to-one relationship has been studied among the three actors.

It would be interesting to simulate a real Supply Chain with the introduction of multiple actors at different echelons and discovering how their interactions could change the results. Furthermore, better results could be achieved in more efficient way, programming Excel macros to simulate the interactions among different Supply Chain actors. Finally, even other analytic tools could be used in future researches to reach higher precision and complexity level, such as S.I.R.I.O., which is a simulation tool that allows to assess the cost differential between different hypotheses. It allows to minimise the overall costs for the chain and understand how costs vary as the variables varies.

Acknowledgments

We want to thank Giulia Cervello and Simone for their support in the performance of the present research. We also thank the companies interviewed for the active support in this study, providing the necessary data to obtain the appraisals presented.

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