

THE IMPACT OF RFID AND EPC NETWORK ON BULLWHIP EFFECT IN THE ITALIAN FMCG SUPPLY CHAIN

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Introduction

The adoption of RFID technology [1] for products identification is experiencing an increasing diffusion in the logistics pipeline, where RFID systems are expected to have a major impact on the efficiency of the whole supply chain. Commonly quoted benefits of RFID encompass increased processes automation, accuracy, and labour efficiency [2]-[3]. There are several reasons for this diffusion, such as, among others, the capability of RFID tags to provide more information about products than traditional barcodes and to avoid manual operations required to read the barcodes [4]-[7], thus improving automation [8]-[9].

Similarly, exploiting EPC Network for data sharing enables users to find on the internet data related to a specific EPC and to gain access and retrieve those data. Through this real-time data sharing mechanism, companies have broad and plain visibility over logistic flows and can leverage this information both to optimize logistics processes and for supply chain management [10].

As discussed by Prater et al. [3], for the specific case of the grocery retailing, the availability of real-time information throughout the supply chain is regarded as the main benefit of EPC Network, although additional outcomes can be found in increased inventory visibility, stock-out and safety stocks reduction, real-time access and update of current store inventory levels, automated Proof Of Delivery (POD) [11], availability of accurate Points Of Sale (POS) data and finally better control of the whole supply chain [12].

Due to easy data capturing and sharing and real-time visibility they bring in the supply chain, RFID technology and EPC Network provide companies with updated retail data, thus allowing improved sales forecasts [13]. Hence, they are also suggested as viable tools to reduce the overall supply chain inventory waste caused by the bullwhip effect (BE) [14]-[15].

Aim and Scope

In this paper, we provide a quantitative assessment of the potential reduction in the bullwhip effect [16], and thus in safety stocks, in the Fast Moving Consumer Goods (FMCG) supply chain. The reduction is grounded on the one hand on RFID technology for product identification and on the other one it is a consequence of real-time visibility of products flows provided by EPC Network.

Accordingly, we focus on the improvements in demand forecasting process, which result from minimizing variability increase on products consumption; thus, we assume that RFID technology and EPC Network impact on the BE by mitigating its first cause (i.e. demand variability and demand signal processing [16]). This is particularly relevant for the FMCG industry, where demand is difficult to predict; moreover, the very high volumes of products that pass through the FMCG supply chain involves poor product visibility [17].

Research methodology

Our analysis refers to the Italian FMCG supply chain. Specifically, a "representative" three-echelon supply chain is examined, composed of a manufacturer's Distribution Centre (DC), a distributor's DC and a retailer department store of FMCG. A scheme of the supply chain analysed is provided in Figure 1.

The main features of the "representative" supply chain were derived from an appropriate data collection phase, which involved a panel of 15 major companies, namely 6 manufacturers and 5 distributors and 4 retailers of FMCG, adhering to GS1 Italy. For each participant, data collection was performed on either a DC or a warehouse, identified by the company as representative of its supply chain processes. As an example, DCs with advanced Information Systems WiFi infrastructures and bar codes scanners for product identification were chosen. At the same time the amount of product flow has played a central role in the selection process. Similar criteria have been adopted to define a retail store for each retailer involved in the study.

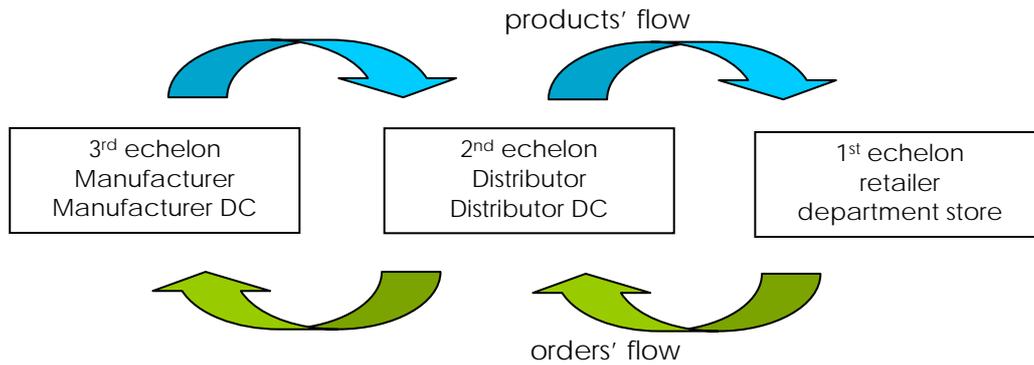


Figure 1: the three-echelon representative supply chain

Ad hoc questionnaires, related to DCs and retail stores, were designed to collect quantitative data related to the structures examined; site visits and direct interviews were exploited to answer the questionnaires.

Data collection phase approximately took from November 2004 to April 2005. The objective of this phase was broader and aimed at assessing the whole impact of RFID on the FMCG supply chain [18]. Site visits involved academics of the University of Parma, a representative of GS1 and one or more members in charge for the visited organization. Follow ups have been carried out by phone in late 2006 to refresh relevant data for the present analysis.

Savings resulting from bullwhip effect reduction were computed following the analytical approach developed by [19] and [20], which have quantified the impact of information visibility on the BE in a simple supply chain and analytically derived a lower bound of demand amplification, in terms of variance ratio, as a function of the level of information sharing.

Data collection has highlighted absence of information sharing between supply chain partners, corresponding to a “decentralised information” scenario [19]. We have assumed sharing of demand data as the “centralised information” scenario, where EPC Network is exploited for real-time RFID information sharing. To this extent, both pallet and case level tagging frameworks are considered.

The decrease in safety stocks was assessed by computing the decrease in demand standard deviation when moving from the decentralise scenario to the centralised one. Inventory costs were also assessed to quantify the economical impact of safety stocks reduction.

In the computation, we focus on BE reduction for the “representative” manufacturer’s DC and distributor’s DC, whose main features are proposed in Table 1.

Table 1: representative features of the FMCG supply chain.

Representative features	Manufacturer’s DC	Distributor’s DC
Procurement lead time L [days]	10	4.5
Mobile mean interval p [days]	6	6
Amount of safety stocks [pallets]	4,000	3,500
Cost of safety stocks [€/year/pallet]	143.47 €	136.51 €

As mentioned before, we have considered two deployment levels of RFID technology, namely pallet level and case level tagging.

Each level implies different effects on products visibility in the supply chain. Under a pallet level tagging scenario, manufacturer is enabled with complete visibility of products up to the distributor’s DC while no additional information is provided on products demand at the retail store, since the latter handles anonymous cases of products. In a case level scenario POS data become available through RFID reads when RFID tagged cases are moved from the back room to replenish the shop floor. EPC Class 1 gen 2 UHF smart labels [21] have been assumed to be adopted for tagging of both cases and pallets.

Results and discussion

Results refer to:

- BE lower bound in a decentralised (actual) and centralised (RFID & EPC Network) scenario, assessed as the ratio between order and demand variance [19];

- savings per year due to safety stocks reduction as a consequence of BE improvement. Savings are assessed per “representative” manufacturer’s and distributor’s DC.

Numeric outcomes are proposed in Table 2.

Table 2: quantification of the bullwhip effect for the “representative” FMCG supply chain.

		Bullwhip effect	
		Manufacturer’s DC	Distributor’s DC
Pallet level tagging	BE Decentralized information LB	35.84	3.62
	BE Centralized information LB	17.51	3.62
	% BE variation	30.10	-
	Economical impact [€/year]	172 738.43	-
Case level tagging	Decentralized information	49.78	5.03
	Centralized information	15.21	4.51
	% BE variation	44.73	5.31
	Economical impact [€/year]	256 686.05	25 387.51

As can be seen from the table, RFID technology and EPC can involve substantial decrease in BE for manufacturer. Specifically, decrease in demand standard deviation accounts for about 30.1% and 44.7% for pallet and case level tagging respectively. Conversely, decrease in demand standard deviation becomes less appreciable for the “representative” distributor.

As mentioned, under a pallet level tagging scenario RFID and EPC implementation can not improve products visibility for the distributor, since information related to department store orders is currently available at the distributor level. As a consequence, no reduction of BE emerges for the second supply chain echelon. In a case level tagging scenario instead, the distributor could benefit from a demand standard deviation reduction of about 5.3%, thanks to improved visibility of POS at the retail store.

From an economical point of view, manufacturer savings resulting from safety stocks reduction account for about 172,738 € per year per DC and 256,686 € per year per DC in pallet and case level tagging scenario respectively. As far as the distributor is concerned, savings accounts for 25,387 € per year per DC, in a case level tagging scenario.

Conclusions and hints for future research directions

Based on the above results, we can first conclude that centralizing information and providing updated POS data exploiting RFID technology and EPC Network implementation has tremendous potentials to reduce the bullwhip effect in the FMCG supply chain. As a matter of fact, results show a considerable decrease in demand standard deviation in all scenarios examined. This is particularly the case for the manufacturer, while the distributor is affected by BE reduction but to a minor extent.

BE reduction, in turn, could substantially affect the profitability of the FMCG supply chain, both under pallet and case level tagging scenarios. In fact, most of the total logistics costs of FMCG supply chain can be ascribed to high inventory levels in the distribution channel. Since the FMCG industry is usually characterised by low-value products, reducing the amount of safety stocks can be right considered as a viable tool to increase products margins and profitability [17].

Focusing on economical outcomes, the manufacturer’s DC can benefit from the highest savings, resulting from considerable reduction of demand variability as a consequence of improved visibility of the whole supply chain. Moreover, benefits achievable in the case level tagging scenario appear as particularly relevant. In such context, manufacturers should sustain high costs of RFID implementation, above all costs for case tagging at the end of the production lines, which could be balanced by benefits resulting from safety stocks reduction due to downstream visibility thanks to the EPC network.

Our quantitative assessment of BE reduction and corresponding savings has been grounded on “representative” data related to the FMCG supply chain; nonetheless, realizing a pilot project of an RFID supply chain, aimed at directly investigating the economical benefits of safety stocks reduction, can be right suggested as a future research step. “In field” measures could also provide empirical evidence of the results obtained in this paper.

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