Information Integration of CPFR in Inbound Logistics of Automotive Manufacturers Based on Internet of Things

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***Abstract*—With the improvement of supply chain management and development of information technology, the nature of business processes has changed from intra-enterprise to cross-enterprise. Collaborative Planning, Forecasting and Replenishment (CPFR) come into being in this case. The literature of CPFR and the Internet of Things are discussed. The information integration of CPFR in inbound logistics of automotive manufacturers is analyzed. The CPFR reference model is designed to fit many scenarios and this research aims to focus on the information integration of CPFR model in the scenario of inbound logistics of automotive manufacturers based on the environment of Internet of Things.**

***Index Terms*—Information Integration, Collaborative Planning, Forecasting and Replenishment (CPFR), Inbound Logistics of Automotive Manufacturers, Internet of Things**

I. Introduction

A methodology referred to as Collaborative Planning, Forecasting and Replenishment (CPFR) has been espoused as a means of integrating all members of the supply chain. The main driving forces for CPFR adoptions there included fierce competition, a shorter product life cycle, offshore production, and the supply chain cost structure. CPFR is a Web-based attempt to coordinate the various activities including production and purchase planning, demand forecasting and inventory replenishment between supply chain trading partners.[1]

Information integration has been recognized as a central problem of modern database systems [2]. Information integration in supply chain refers to the sharing of information and knowledge among members of the supply chain, including demand information, inventory status, capacity plans, etc. Information integration efforts between members of the supply chain, in the form of information sharing, synchronized replenishment, and collaborative product design and development, have been cited as major means to improve supply chain performance [3].

Internet of Things was firstly mentioned by Bill Gates in his “Future” in 1995 and the idea could not really achieve because of the restrictions of the technology of network terminals at that time. Nowadays Internet of Things once again debuts and became the focus of national attention. However, Internet of Things is still in a very early stage, and it will take a long time for it to achieve large-scale development in order to let the public enjoy its full functions. This paper mainly studies the information integration of CPFR model in inbound logistics of automotive manufacturers based on Internet of Things.

II. Literature Review

In this section, we review the literature on information integration of CPFR model, inbound logistics of automotive manufacturers and the Internet of Things. The literature review provides the theoretical foundation for this research.

Collaborative Planning, Forecasting, and Replenishment (CPFR) was defined by the Voluntary Inter-industry Commerce Standards (VICS) committee as a way of describing supply chain collaboration [4]. It defined CPFR as “a collection of new business practices that leverage the Internet and EDI in order to radically reduce inventories and expenses while improving customer service.” Compared with previous strategic alliances, CPFR concentrated on strongly linking business planning, forecasting, and replenishment through deeper information sharing. CPFR provides a good collaboration alternative based on integrating internal and external business activities.

Inbound logistics of automotive manufacturers is for logistics service provider to provide timely and quick service in accordance with the requirements of automotive manufacturers, including automotive parts transportation, storage, handling, packaging, distribution processing, information processing and other basic functions. Main researches are focused on the study of factors affecting inbound logistics of automotive manufacturers and the operation modes of inbound logistics of automotive manufacturers. Alan Harrison summed up 6 major operation modes of automotive inbound logistics through analyzing of motor companies.[5] Matthias Holweg and Joe Miemczyk compared the implications on inbound, outbound and sea transportation logistics, leading to the development of a

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strategic framework for future automotive logistics operations. [6]

The concept of Internet of Things was proposed in 1999. At that time, based on Internet, RFID technology, EPC standards and on the basis of the computer Internet, "Internet of Things" was constructed to achieve the Internet of global real-time sharing information of the physical items. This is also the first round of Internet of Things boom in 2003. In November 2005, the International Telecommunication Union (ITU) released the "ITU Internet Reports 2005: Internet of Things" and cited the concept of Internet of Things. The report notes that Internet of Things is a technological revolution that represents the future of computing and communications, and its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology [7]. Internet of Things is not technology fantasy but a technological revolution. It makes the goods and services occurring qualitative leap. And these new features would bring users further efficiency, convenience and safety.

III. Information Integration of CPFR in Inbound Logistics of Automotive Manufacturers

A. CPFR process model

Nowadays CPFR is being implemented at thousands of companies across the globe. Many companies, such as GSK, are implementing CPFR with multiple retailers. As is shown in Figure 1, the latest version of the CPFR guidelines, edited by the VICS CPFR committee in 2004, is an interactive cycle of four main activities, so called Collaboration Activities:

①Strategy and planning——to establish the ground rules for the collaborative, determine products mix and placement, and development event plans for the period;

②Demand & supply management——to project POS demand and order and shipment requirements;

③Execution——to place orders, prepare and deliver shipments, receive and stock product on retail shelves, record sales transactions and make payments;

④Analysis——to monitor planning and execution activities for exception conditions, aggregate results, and calculate key performance metrics, and share insights and adjust plans for continuously improved results [8] .

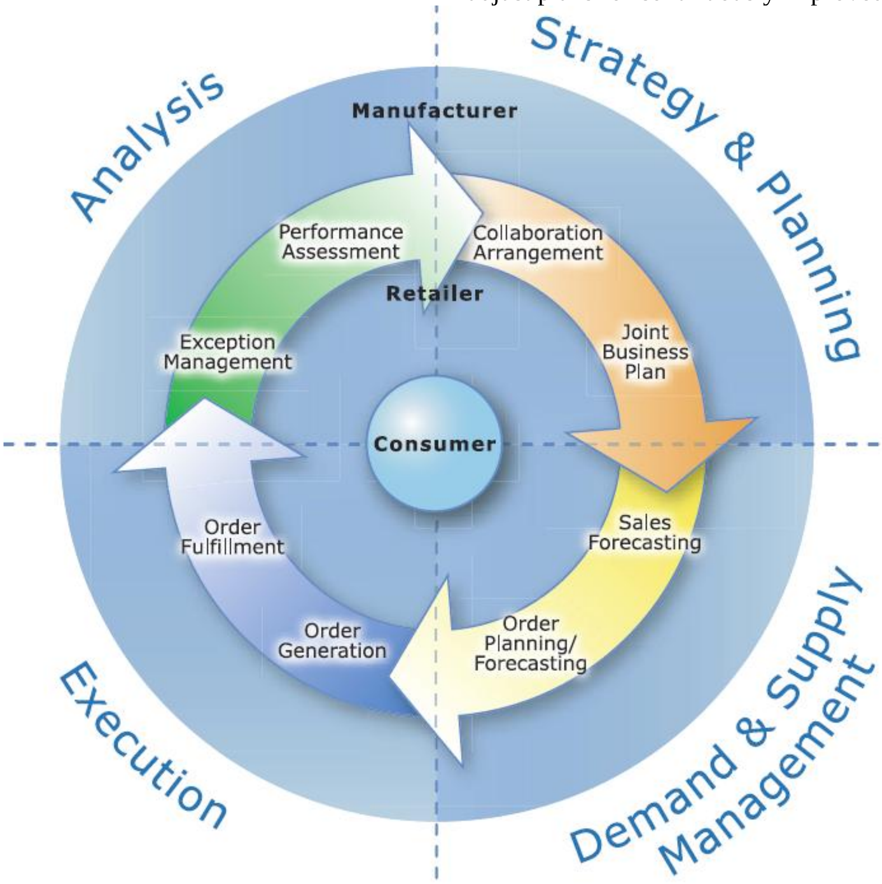

Figure 1 CPFR Process Model[8]

B. Information Flow Model of CPFR

In the three stages of CPFR, new information is generated depending on the data flow analysis and is for use of the next stage. The information generated is shared between all members in supply chain, including distribution and retail activities.

In the planning stage, there are two things need to do: the first is to institute exception standard according to historical shipment and POS data, the second is to co-establish joint business planning and project management files according to all the partners' own strategic planning and strategy. In the forecasting stage, the first is to constitute sales forecast and identify abnormal items according to the joint business plan, POS data, unusual standards and events; the second is to establish order forecast and identify abnormal project according to POS data, inventory information, sales forecasts, events, history volume of demand, product availability data and project management files. In the replenishment stage, it is necessary to generate orders according to sales forecast and project management.

Whether the information model of CPFR is simple or not is in relation to the arrange ways of CPFR. The ways to arrange the application of CPFR include sharing mode and peer to peer mode. The sharing mode appears to be more flexible than peer to peer mode because in sharing mode all members share the same database without considering the synchronization problems of complex data. The peer to peer made allows each member has its own independent CPFR applications and these applications can be interoperable. But the weakness in this approach is that it is very troublesome to realize the synchronization exchange of data. Clearly, the peer to peer mode is more suitable to type of information-sharing structure of the whole channel, while the sharing mode is more suitable to hub (center) type of information sharing structure.

The sales forecast information flow mode corresponding to Figure 2 is as follows:

1. Send Usage
Event: Generating sales forecasts
Sender: Hub
Receiver: Member A / Member B
Data_ object: sales forecast
Data template: XML model of sales forecast
Req action: Confirming sales forecast
Mode: Real-time
2. Confirm Sales Forest
Event: Receiving sales forecast
Sender: Member A / Member B
Receiver: Hub
Data_ object: sales forecast
Data template: XML model of sales forecast
Req_action: Generating replenishment orders
Mode: Real-time [9]

C. Information integration of CPFR

The above information-sharing model can be used to address two key issues of CPFR: the inaccuracy of forecast and abnormal generated by fluctuation in supply and demand. Figure 3 shows the information exchange among members of a traditional automotive supply chain, Figure 4 shows the information integration of CPFR model supply chain and Figure 5 shows the demand information pipelines of automotive supply chain. Information integration comprises information sharing and collaborative planning. Information sharing refers to the exchange of critical, often proprietary, information between supply chain members [10]. Under CPFR, inventory levels, POS data, promotion plans, sales forecasts and all other information that may be influential on the market demand are shared between supply chain members.

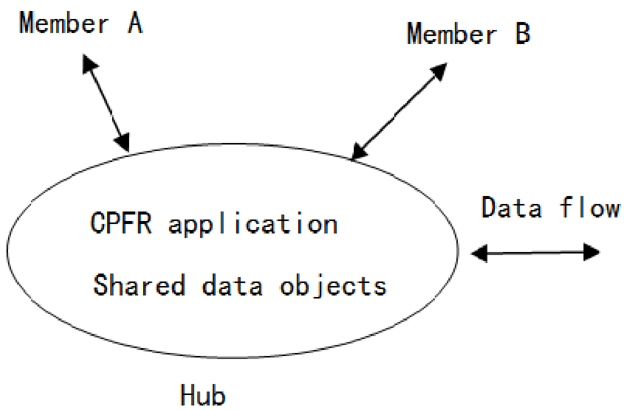

Figure 2 A simple example of sharing arrange of CPFR [9]

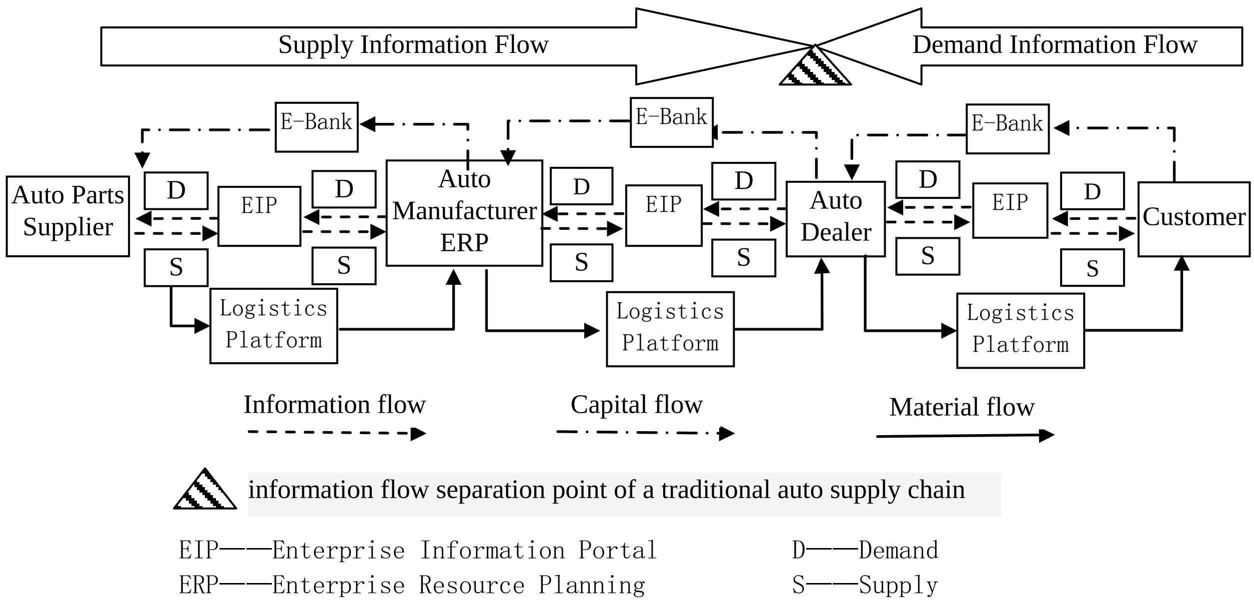

Figure 3 Information exchange among members of a traditional automotive supply chain

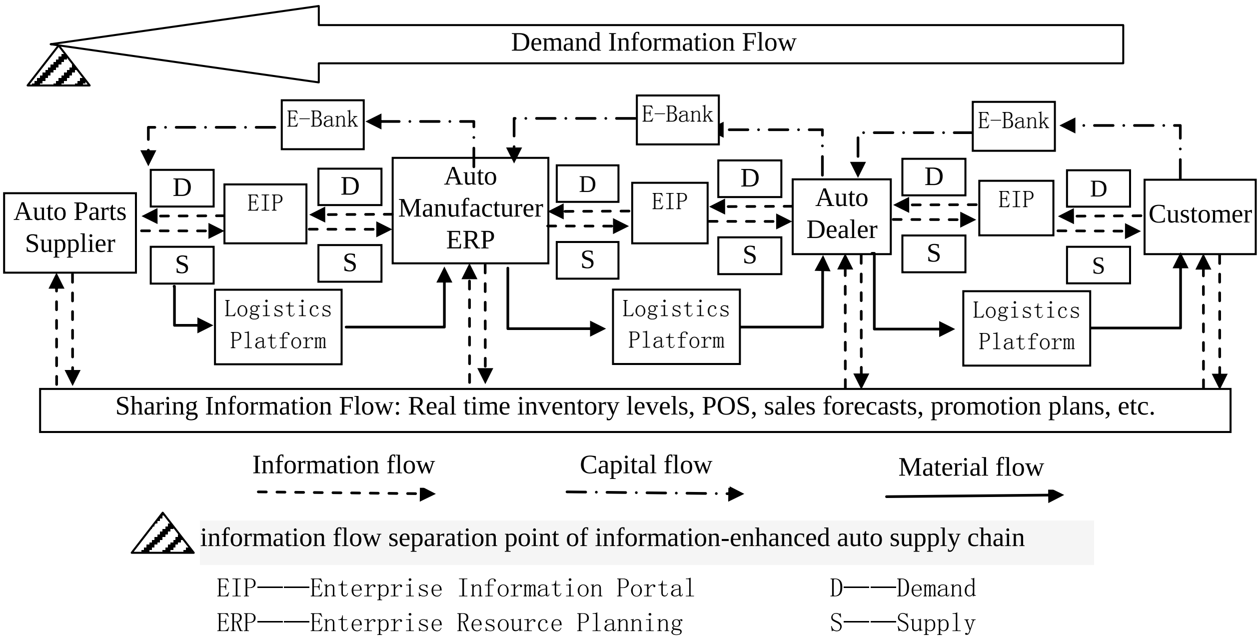

Figure 4 Information integration of CPFR automotive supply chain

D. Information Flow of CPFR in Inbound Logistics of Automotive Manufacturers

Collaboration is as well aspired in the automotive industry during the development process of a new vehicle. At early stage automotive manufacturers cooperate just with few definite suppliers and nowadays they collaborate and share explicit construction plans with their suppliers. Automotive manufacturers focus more on specific customer demands and have to deal with a narrow time-frame from an order to a delivery. So there is a need for a high complex logistic network and a necessary flexible cooperation between automotive manufacturers and parts suppliers. The objectives of collaborative forecasting with suppliers and collaborative replenishment with their dealers are an increased satisfaction and enthusiasm of customers which could lead to higher sales, greater profitability and an improved market share.

General Motors, the largest automotive manufacturer in the world, used the concept of CPFR. Figure 3 highlights the collaborative information flow from the supplier to the customers of Demand Sensing framed by CPFR at General Motors.

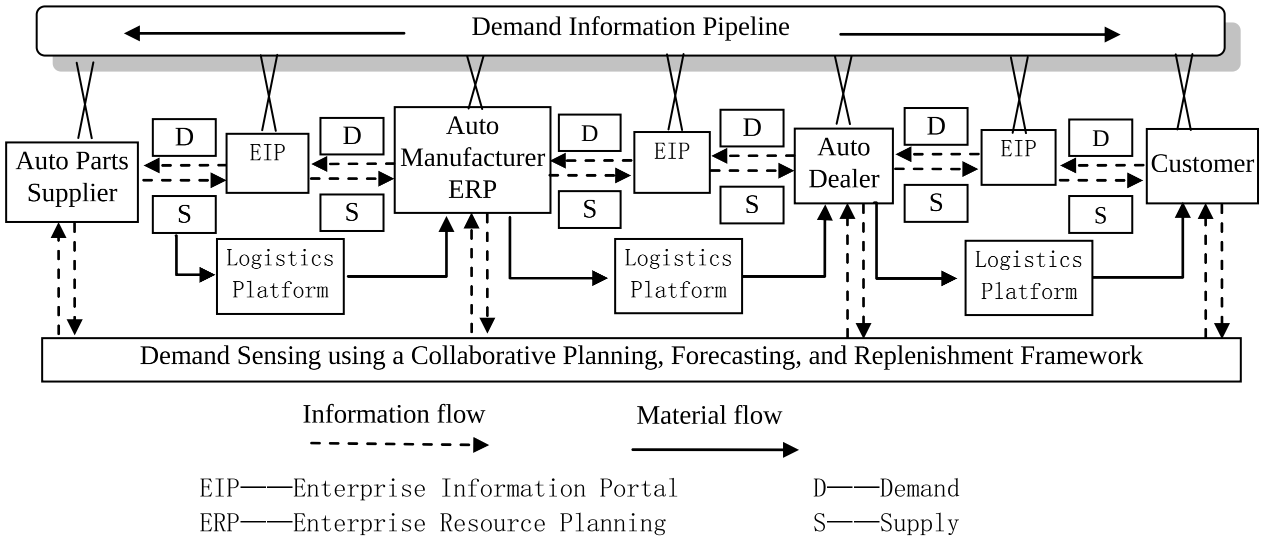

Figure 5 Demand Information Pipelines of automotive supply chain

In deciding the mode of information flow in Automotive industry, the main questions to be solved are about how to identify correct demand signals, what information needs to be captured and what value and quality has the information at each stage. Therefore, analyzing databases containing order information, sales and inventory and click stream data should be carefully investigated and studied. And collaborative forecasting has been investigated in order to create more visibility for upstream suppliers and effective respond to demand changes on a daily basis instead of only a monthly or weekly exchange. This is realizable by supply chain partners through an exchange of relevant data, co-managing forecast requirements and refines capacity and replenishment plans. [10]

IV. Information integration of CPFR in Inbound Logistics of Automotive Manufacturers Based on Internet of Things

A. Requirement for "Things" to be connected in Internet

The Internet of Things is a technological revolution that represents the future of computing and communication, and its development depends on dynamic technical innovation in a number of importation fields, from wireless sensors to nanotechnology [12]. RFID technology, which uses radio waves to identify items, is seen as one of the pivotal enabler of the Internet of Things. RFID technology is gradually applied to supply chain management through arming the "things" in supply chain with RFID devices.

In the context of "Internet of Things" a "thing" could be defined as a real/physical or digital/virtual entity that exists and move in space and time and is capable of being identified. Things are commonly identified either by assigned identification numbers, names and/or location addresses [11]. The "things" in supply chain include raw materials, semi-finished products, products etc.

In order to guarantee all of the "things" in supply chain could be fitted with RFID devices, the following requirements should be met:

First, in order to connect all the objects and devices including raw materials, semi-finished products and products to large databases and networks, it is crucial to build a simple, unobtrusive and cost-effective system of item identification. RFID offers such functionality.

Second, data collection will benefit from the ability to detect changes in the physical status of things, using sensor technologies. This is what the bar code technology cannot do.

Finally, advances in miniaturization and nanotechnology mean that smaller and smaller things will have the ability to interact and connect. This also contributes all the "things" could be identified. [12]

B. Information integration of CPFR model based on Internet of Things

In the above environment, information integration of CPFR supply chain would change a lot, as is shown in Figure 6 and all of the "things" in supply chain will take on smart characteristics and capabilities. This will give significant benefits to the integrated information processing. The influences of Internet of to CPFR supply chain management include optimizing supply chain management process, making effective use of resources, realizing truly real-time management, increasing supply chain visibility, improving the transparency of information in supply chain management and making supply chain management to achieve a high degree of agility and fully integrated.

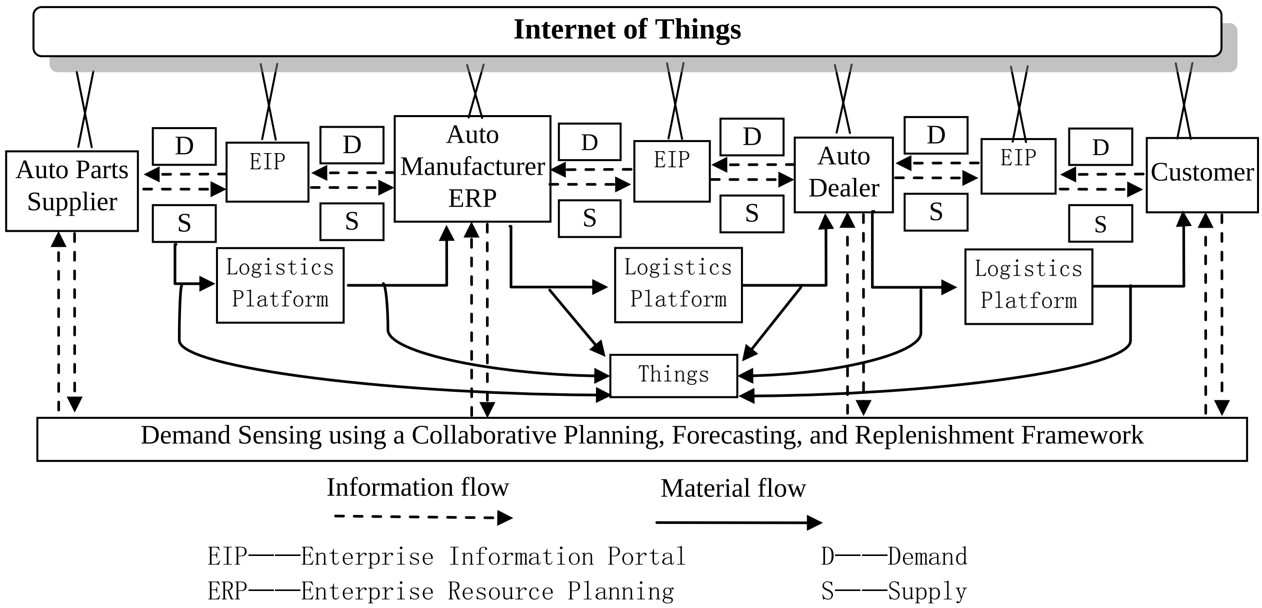

Figure 6 Information integration of CPFR automotive supply chain based on Internet of Things

C. Information integration of CPFR in Inbound Logistics of Automotive Manufacturers Based on Internet of Things

Inbound logistics of automotive manufacturers is very complex especially nowadays cars are manufactured specific to the customer's needs. The forecasting of accurate demand figures in the automotive industry becomes complicated with the shorter and shorter product life cycle, the steady change of customers' taste, the inaccurately calculated demand figures which are not shared with their suppliers. The deployment of CPFR seems to be most feasible with Japanese car manufacturers, as Toyota already developed a strong and trustful buyer-supplier relationship which is crucial for the collaborative planning and forecasting processes. Nowadays, Toyota has core first tier suppliers and second tier suppliers. Most of the first-tier suppliers, which manufacture high value components tailored to Toyotas specific needs, are subsidiaries or affiliated companies. In general, the relationship between a Japanese car manufacturer and its suppliers present very high levels of trust so that confidential information can be shared with their suppliers without concerns (Emerald, 2003).

In the automotive industry, about 70 percent of the value added chain is operated at the supplier (Kleinert, 2006) so the principle of cost saving through the intended collaboration by CPFR seems especially promising for the automotive sector. In order to decline inventory and apply continuous replenishment, transportation had to be reorganized. Re-education of plants on just-in-time approach was introduced. It is a strategy to manage inventory by delivering raw material and components from the vendor immediately as they are required (International Data Group, 2007). As is shown in Figure 7, the four main activities of CPFR in Inbound logistics of automotive manufacturers based on Internet of Things are as follows.

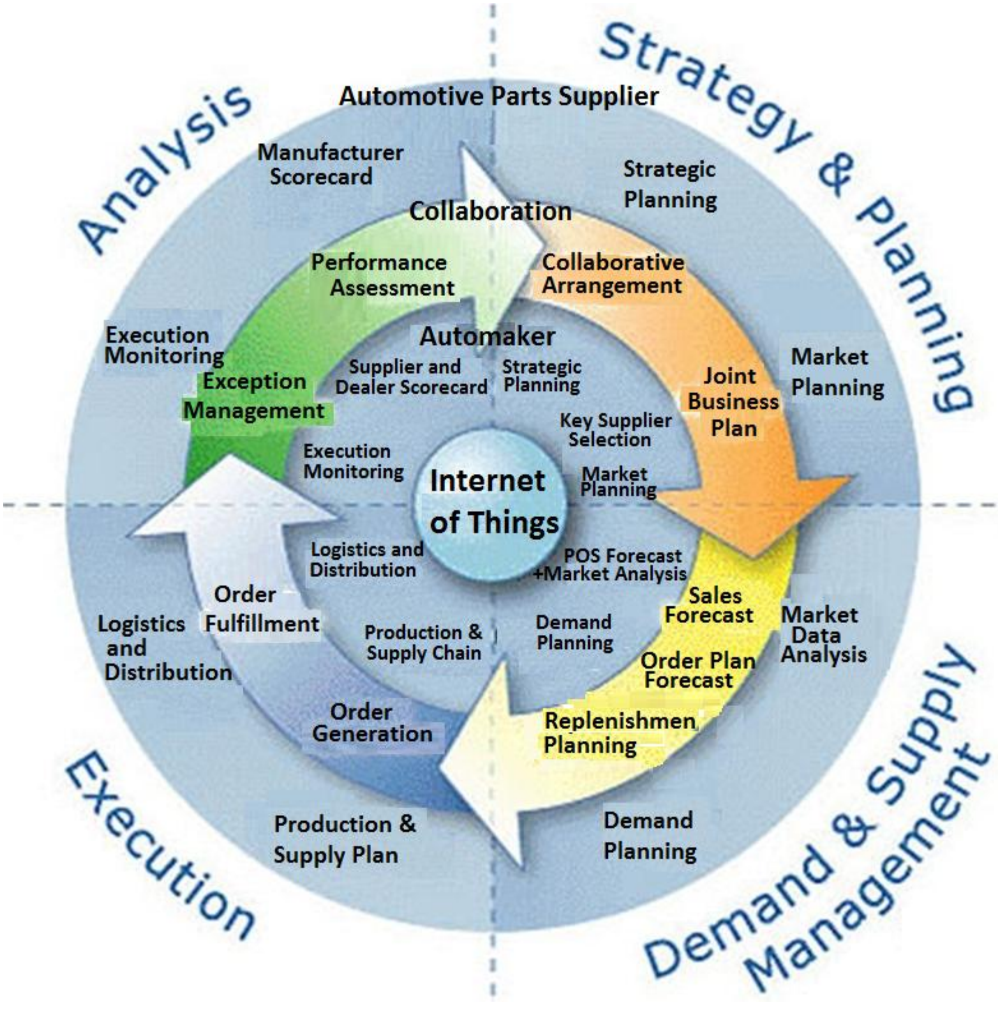

Figure 7 CPFR Model in Inbound Logistics of Automotive Manufacturers Based on Internet of Things[12]

1. Strategy and planning

The first collaborative step of CPFR in inbound logistics of automotive manufacturers is to define the rules and basic principles for the collaboration between the car manufacturer and the parts supplier. The car manufacturer must be aware of its strategic planning and the suppliers have to be evaluated thoroughly. A significant purchase volume as well as sufficient system capabilities and a trustful relationship are the most important selection criteria [12].

2. Demand and supply management

The second collaborative step of CPFR in inbound logistics of automotive manufacturers is to demand and supply management. In order to generate a sales forecast in terms of CPFR, data from both the automaker and its supplier are required. Based on Internet of Things, the automotive manufacturer easily collects sales data from its dealers (POS Forecast) and analyzes the market and all collected data flow in a conjointly generated Sales Forecast visible for all parties at all times. On the one side the supplier can appraise the required volume of future deliveries and on the other side; both parties can determine conjointly the appropriate delivery methods for the different vehicle parts for the future collaboration. With the help of demand planning carried out by the manufacturer and the supplier, a combined Replenishment Planning is generated [12].

3. Execution

The third collaborative step of CPFR in Inbound logistics of automotive manufacturers is execution. Based on the aforementioned strategic planning the Order Generation activity is done conjointly. Then, the supplier and the car manufacturer compile their own production and supply plan. However, the production and supply planning process is a continuous process which is enhanced during the production. Within the same activity, the car manufacturer carries out its buying or re-buying process, as he transfers his buying requests to his suppliers. Afterwards, the order is fulfilled while the finished products of the car manufacturer are distributed to the retailer and the supplier allocates his products to the car manufacturer [12].

4. Analysis

The fourth collaborative step of CPFR in Inbound logistics of automotive manufacturers is analysis. Data from the demand and supply management will be compared with the actual execution. Safety stocks or the accuracy of forecast figures are checked, for instance. The automotive manufacturer uses supplier and dealer scorecards to measure the degree of target achievements. In order to evaluate achievements, uncover trends and create alternative strategies, performance management is used by both, the automotive manufacturer and the parts supplier, together [13].

V. CONCLUSION

The information integration in CPFR and the Internet of Things are both focus of research in present-day society. This paper is carried out to make analysis of information integration of CPFR in Inbound logistics of automotive manufacturers based on the environment of Internet of Things. This analysis aims to provide a new vision to research the Supply Chain Management.

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