Framework and Development of a Collaborative Supply Chain Model

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***Abstract*— One of the most critical issues of inventory management is Customer demand (intermittent demand, request for change in product, process or phase in / out). Variation in demand increases the difficulty of determining the precise amount of inventory both to avoid stockout and to satisfy the customer fill rate. The inventory control problem is getting complicated by the fact that demand is uncertain or the variation of demand is highly volatile. [1]. Many practical systems such as manufacturing and inventory systems applications are mostly used to model categorical data sequences. [2]. Results indicate that firms that focus on flexibility, quality, and delivery should develop strategic collaboration with suppliers & customers to achieve market and innovation improvement. Cost- and quality-focused firms should develop operational collaboration to achieve resource efficiency. The model allows understanding the right alignment of external suppliers and customers being pursued to for key performance development and continuous improvement insight.**

***Keywords*—** *Inventory, Supply chain, customer demand, slow movers, obsoletes, continuous improvement, supply chain collaboration.*

1. Introduction

Facing uncertain environments, firms (e.g., Hewlett-Packard, IBM, Dell, Procter and Gamble) have strived to achieve greater supply chain collaboration to leverage the resources and knowledge of their key suppliers and customers. [3]

Despite the benefits of supply chain collaborations, many of them fail to meet the expectations. It seems that collaboration has the most unsatisfactory track record of all supply chain management strategies. Supply chain collaboration seems to have great potential but further investigation is needed to recognize its value. In this chapter, we discuss research background, gaps in literature, research questions, and purported contributions. We also clarify some key concepts including cooperation, coordination, integration, and collaboration; joint value. creation versus value appropriation; common benefits versus private benefits; collaborative advantage versus competitive advantage.

The paper aims to find out whether appropriate choice of collaboration model will enable the required inventory control leading to improved business outcomes and supply chain key performance indexes.

2. Global supply chain network in manufacturing industry.

2.1) Parameters impacting the inventory control.

One of the crucial element that determine the key performance index on supply chain is the inventory control which is directly impacted by the customer intermittent demand which is relevant to talk about the PPCM (Product and Process Change Management). [4].

Moreover to have an overview about the impact of the product and process changes this is requested by internal or external customer / supplier affecting:

- The product design.
- Change of the product drawing.
- Change in the production process.
- Change of the technical or functional use of the product: (length, ergonomic, life cycle…).
- The phase in of new article and the phase out of old one.
- Finished good component changes.
- BOM (Bill of material) change.
- Change of supplier/ customer product [5].

The list of the above parameters drive to many consequences and effects that directly impact the global supply chain key performance especially the inventory control such as :

- Increased stock value of slow moving parts.
- The increased stock value of the run out / obsoleted articles.
- The decreased demand of the old articles.
- The overlapping order between the new and old article.

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- Increased stock leftover of the old article after change implementation.
- High scrapping value of the old article [4].

Excessively gathered stocks consist of either obsolete parts, which currently are not used or any further customer demand of this article, and the ones which are excessively gathered, i.e. not adjusted to the level of use. A high level of slow movers or obsolete parts which are maintained in enterprises are frequently not justified economically since this stock corrode or shelf life but, most of all, freeze capital. The main reasons of the occurrence of excess and obsolete inventory, below an overview about stock evolution of slow movers due to customer change from high runner article to slow mover one, and this change drive to the below status which affect directly the stock level value [5]:

2.1.1) Slow moving stock evolution, impacted by customer product change

Below an overview about slow moving stock evolution, impacted by customer product change, during one year observation period.

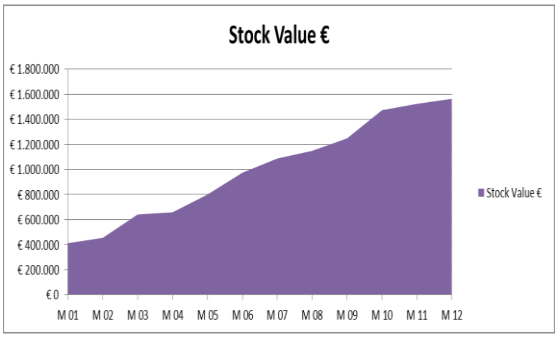

Figure 1: Slow movers stock evolution during one year observation period.

The figure.1 shown that the customer change product is directly impact the global stock inventory of the company, due to the decreased demand of the old articles which increased the slow moving stock value compared to the company's regular stock.

2.1.2) Stock classification:

The impacted stock by customer change products of slow moving, obsolete parts and articles without demand within 365 days, are representing more than 20 % of the global stock of the company's during one year observation period.

This amount of stock leaded by many parameters and reflected in the below **figure.2**:

- The overproduction of the old version of the article.
- The lack of communication between different supply chain actors.
- The inaccuracy of customer forecasts.
- The customer volatility.
- The customer / supplier change request in firm zone agreement [6]...

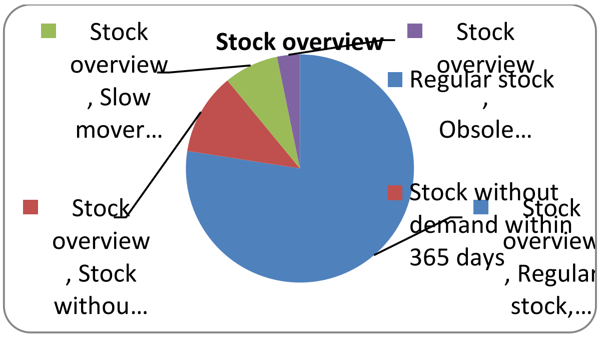

Figure 2: The global stock overview during one year observation period.

3. Case study: Proposal of a collaboration model for the global supply chain management.

3.1) the effects of enterprise technology on supply chain collaboration and performance.

This study is to investigate the effects of enterprise technology on supply chain collaboration and performance. Structural equation modeling is employed to test the multi-phased conceptual model which is shown in **Figure 3**. Enterprise technology assimilation is indicated using two factors: enterprise technology use for exploitation (F1) and enterprise technology use for exploration (F2). Based on the theory of organizational learning [7],we define enterprise technology assimilation for exploitation as the use of technology for the execution of supply china routine processes. Similarly, enterprise technology assimilation for exploration is defined as the implementation of unstructured and strategic supply chain activities. Planning collaboration (F3) and forecasting and replenishing coordination (F4) are considered as supply chain collaboration measures. Collaboration and coordination in planning is defined as jointly plan for supply chain key activities [8] while operational collaboration and coordination are defined as information sharing to achieve efficient task execution [9].

Operational benefits (F5) are defined as first-order benefits, arise directly from effective supply chain collaboration.

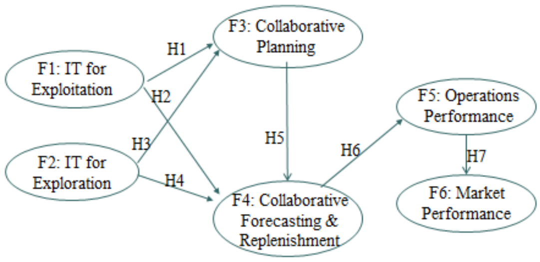

Figure 3: Research Model

Conversely, benefits for market performance (F6) arise through better operational performance supported by supply chain collaboration [10].

3.2) Enterprise Technology and Supply Chain Collaboration

A supply chain is as strong as its weakest link. The notion here focuses on strong and effective collaboration. The fundamental point that distinguishes supply chain management and traditional materials management is how the collaboration of trading partners is managed. Thus, collaboration is a most talked about issue in today's global supply chain management. In recent years, retailers have initiated collaborative agreements with their supply chain partners to establish on-going planning, forecasting, and replenishment process. This initiative is called collaborative planning, forecasting, and replenishment (CPFR) [10]. We may conclude that supply chain collaboration has great potential in supply chain management, but further investigation is needed to understand its practical value. As such, we hypothesize the following:

Hypothesis 1: The higher the level of enterprise information technology use for exploitation the greater the supply chain perceived level of collaborative planning.

Hypothesis 2: The higher the level of enterprise information technology use for exploitation the greater the supply chain perceived level of collaborative forecasting and replenishment.

Hypothesis 3: The higher the level of enterprise information technology use for exploration the greater the supply chain perceived level of collaborative planning.

Hypothesis 4: The higher the level of enterprise information technology use for exploration the greater the supply chain perceived level of collaborative forecasting and replenishment.

A sequential collaborative process [11] The process has nine steps which are divided into three phases. The first is planning phase, which consists of steps 1 and 2, and creates the collaborative front-end agreement and joint business plan. The second is the forecasting phase, including steps 3-8, and the last is the replenishment phase (step 9). Specifically, a sequential process is introduced. The second and third phases execute supply chain orders which are translated from the joint business plan which is determined at the first phase [12].

The importance of collaborative has been well documented. For example, in the spring of 2001, Sears and Michelin (a French company) began discussions on collaborative planning. Later that year, their joint plan detailed a collaborative forecasting and replenishment agreement. As the result of collaboration, the combined Michelin and Sears inventory levels were reduced by 25 percent [12]. This supports our following hypothesis. Hypothesis 5: The higher the level of collaborative planning the better the execution of collaborative forecasting and replenishment.

3.3) Construct Measure and Reliability

Our conceptual model involves relationships among six constructs. In this section, we provide evidence that the measurement of these constructs has been effective in terms of reliability and validity. All of the survey items that were used for measurement of the constructs are listed in Table 1. Empirical support for effective measurement is provided by a Cronbach Alpha. Enterprise technology for exploitation was measured using three items. The reliability for the scale is 0.81 (Table 1). Enterprise technology for exploration was measured using a three times. The reliability is 0.817 (Table 1).

The reliabilities for collaborative planning and collaborative forecasting and replenishment are 0.756 and 0.868 respectively. Finally, the reliabilities for operational performance and market performance are 0.805 and 0.804 respectively.

3.4) Findings Related to Hypotheses

We further investigated the findings related to specific hypothesis and individual paths of the model. The set of four hypotheses relate to enterprise technology and supply chain collaboration is examined first.

Hypothesis 1 is not significant.

Hypothesis 2 is supported at $p<0.10$ ($\alpha_1=0.157$).

Hypothesis 3 is supported at $p<0.01$ ($\alpha_2=0.462$).

Hypothesis 4 is supported at $p<0.01$ ($\alpha_3=0.257$).

This set of findings reveals some valuable insights on how enterprise technologies facilitate supply chain collaboration. The result suggests that applying enterprise technology for exploitation directly affects operational collaboration such as demand forecasting and inventory replenishment. However, it does not have a significant impact on collaborative planning. Furthermore, applying enterprise technology for exploration, which focuses on identifying the trends in sales and operations management and leveraging firm's expertise to create new markets and production,

has direct positive effect on both collaborative planning and collaborative forecasting and replenishment. The results from this study underscore the complexity of the construct of enterprise technology exploitation and indicate that exploration may have an overarching impact on supply chain collaboration. These findings suggest that enterprise technology use creates a unique and specific value to collaborations within supply chain.

Next, we look at the hypothesis that relates the collaborative planning construct to collaborative forecasting and replenishment.

Hypothesis 5 is supported at $p<0.01$ ($\alpha_1=0.3901$).

The finding provides support for the sequential process of collaborative planning and collaborative operational activities. A possible explanation is that sharing information through enterprise technology and making collaborative plans are not enough to improve operations performance. In order to achieve better inventory and lead time performance, supply chain managers have to be able to get involved with the complexity of collaborative planning with multiple echelons in a supply chain and implement the plan through demand forecast and inventory management. This finding is consistent with the result obtained by Disney et al. [13]

Finally, we examined the hypotheses that relate supply chain collaboration to operations and market performance.

Hypothesis 6 is supported at $p<0.01$ ($\alpha_2=0.2842$).

Hypothesis 7 is supported at $p<0.01$ ($\alpha_3=0.6189$).

Pos	Description	coef	val	Alp
EIT1	Use ET to schedule production and plan material requirement	0.6	8.4	0.8
EIT2	Use ET to process order and invoices, and establish new accounts	1	14.1	
EIT3	Use ET to share delivery information and facilitate shipments	0.6	9.5	
ERT1	Understand trends in sales & operations management	0.8	11.4	0.7
ERT2	Integrate production design and manufacturing functions	0.8	12.9	
ERT3	Leverage firm's expertise to create new business opportunities	0.6	9.4	
CP1	Production planning information and data are shared with channel members	0.3	4.4	0.6
CP2	The channel managers communicate on overall business decisions	0.7	9.8	
CP3	Planning for new markets and products with channel members	0.5	7.4	
CP4	Production & capacity are jointly planned	0.7	11.0	
FR1	Sales forecasting & demand mgt are developed through supply chain coordination	0.7	11.0	0.8
FR2	Inventory level information is shared within the supply chain	0.7	11.0	
FR3	Delivery schedule and responsibilities are detailed in contracts	0.8	12.1	
FR4	Channel-wide available-to-promise system is implemented	0.7	10.1	
OP1	Inventory performance has improved, safety stock and stock out has reduced due to collaboration	0.7	10.4	0.8
OP2	Lead time has reduced due to supply chain collaboration	0.8	11.7	
MP1	Created new products and new markets	0.7	10.9	0.8
MP2	Learned new economic growth opportunity and developed new business opportunities	0.8	11.7	
MP3	Improved customer retaining and attracted new customers	0.7	10.1	

Table 1. Value and affectation basing on multi-criteria choice [14].

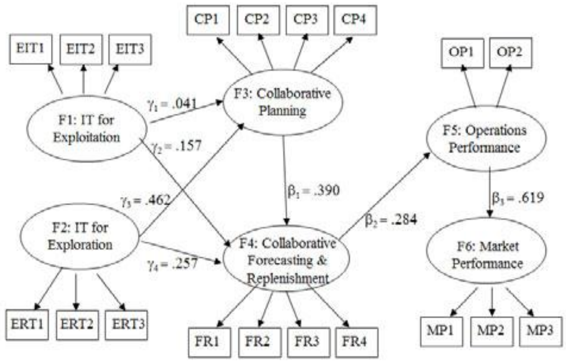

Figure.4 Covariance Structure Model

4. Discussions & results

The findings suggest that collaborative forecasting and replenishment will significantly benefit operational performance. Better operations performance is found to have a significant impact on firm's market performance. In summary, six of seven hypotheses have been supported by the results of the statistical analysis using data from 20 automotive firms. Examining the results, some tentative conclusions can be made. First, enterprise information technology implementation significantly affects collaborative planning, forecasting, and inventory replenishment in a supply chain. Second, supply chain collaboration benefits firm's operational performance. Finally, market competitiveness is influenced by operations performance [14].

Collaboration is a very broad and encompassing term and when it is put in the context of the supply chain it needs yet further clarification [15]. The complex nature of supply chains adds difficulties in the elements involved in the concept of supply chain collaboration. The literature review undertaken, although not exhaustive, served as a comprehensive base for understanding and developing a framework for supply chain collaboration. Two major pillars were identified: the design and government of supply chain activities, and the establishment and maintenance of supply chain relationships [16].

5. Conclusion and limitations

Regarding the overall proposed research framework, the case study identified the importance of the elements of trust, power, dependence, and risk/reward sharing in establishing and maintaining supply chain relationships, as

well as, the role of the above elements in selecting partner, deciding upon collaboration width and depth.

However, the issue of selecting information and data sharing techniques and technologies needs also to be tackled, in particular its interrelation with the elements of the second pillar. The propositions developed in this paper, as well as the overall framework for supply chain collaboration offer scope for further testing and development. They should be seen as an effort to an improved understanding of collaboration.

The study has two main limitations. The first limitation is that the research draws from one relationship only.

Further qualitative testing of the conceptual model is needed with the aim of literal or theoretical replication [17].
The second limitation is the focus on dyadic relationships; extending the research focus to more complex supply chain relationships across the entire chain would be also useful. While none of the factors identified in the research are truly new or novel, they have never been studied in the automotive industry context before, and this is the key contribution of this study. Future research on supply chain collaboration is required in order to develop a more clear understanding of the benefits, as well as, the risks of supply chain collaboration and the way the aforementioned elements of trust, power and dependence interact in the collaboration building process [14].

Headings:

1) **Introduction**
2) **Global supply chain network in manufacturing industry.**
3) **Case study : Proposal of a collaboration model for the global supply chain management.**
4) **Discussions & result**
5) **Conclusion and limitations**

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