CLOUD-BASED SCM SERVICES FOR IMPROVING MATERIAL FLOW OF KEY COMPONENT AND FINISH PRODUCT OF HIGH-TECH INDUSTRY

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ABSTRACT

High degree of demand change is one of the important characteristics of rapidly expanding key component market on its growth stage of high-tech industry. Collaboration that includes essential information sharing and core operations coordination is indispensable for achieving efficient SCM and maximizing SC profits under those uncertain situations. In the research, we propose Cloud-based SCM Services to support up-to-date market demand information sharing that makes it possible to synchronize the management process in operational level among the SC community. Also the Services calculate and provide evaluation value of potential risks to improve material flow of key component and finish product.

Keywords: Cloud-based SCM Services, Key component market, Collaboration

INTRODUCTION

Severe demand change, which includes demand variation and fluctuation from intensified competition or temporary imbalance between supply and demand, is one the important characteristics of rapidly expanding market in those days. And the problematic situations are getting worse in cased of key component market on its growth stage of high-tech industry such as Flat Panel HDTV and Table PC (Kereng et al, 2009; Yoo et al, 2010). Manufacturers strategically collaborate with its SC partners and collaboratively manage intra- and inter-organizational process in order to achieve effectiveness and efficiency, and moreover its primary goal is to maximize the value of the SC (Flynn, 2010). Collaboration, which includes essential information sharing and core operations coordination among the SC community, is the systematic and synchronized business initiatives to achieve efficient SCM and maximizing SC profits. However, it is still the challenging issue to keep the stable and also profitable competitiveness especially in high-tech industry experiencing severe demand change.

In the research, we propose Cloud-based SCM Services that is composed of two major features, which are 'Forecasted Demand Deployment' and 'Potential Risks Evaluation'. 'Forecasted Demand Deployment' service supports up-to-date market demand information sharing that makes it possible to synchronize the management process in operational level among the SC community. And 'Potential Risks Evaluation' service calculates and provides the evaluated value of potential risks to improve material flow of key component and finish product along the SC. Also, we briefly verify strengths and weaknesses of the proposed Cloud-based SCM Services by dynamic simulation with market condition of high demand uncertainty.

LITERATURE REVIEW

There is a stream of research focusing on severe demand change in high-tech industry and seeking solutions to the related problems in various domains and management levels. Banerjee et al. (2010) identified demand of a product is generally in its dynamic characteristics in real market especially in high-tech industry, and the market price is also an important factor that influences severe demand change. And they propose inventory model for seasonal demand with option to change procurement sources. Law et al. (2012) pointed out to succeed in sustainable development has been a global topic and it is widely considered as one of the important issues concerning the high-tech industry. Tsai et al (2009) developed decision making model of product innovation with capital investment under great uncertainty in the case of high-tech industry in which the manufacturer facing a volatile market demand.

Also there is research related with coordination mechanism among the SC community. Anand et al. (1997) compared the performance by the different levels of coordination structures which are decentralized, centralized and distributed coordination. Balakrishnan et al. (2004) explored new approach to coordinate multiple stages in SC by controlling the demand variability that is propagated to upstream stages. Xu et al. (2006) developed and illustrated an attribute-based, systematic process for selecting coordination mechanisms in SC.

Recently, many papers of which topics are oriented from cloud computing and its applied services are reported as original research article. Espadas et al. (2011) identified specific requirements of cloud computing infrastructures and also they proposed tenant-based model as a SaaS application considering cost-effective scalable environment. Marston et al. (2011) identified the strengths, weaknesses, opportunities and threats for the cloud computing industry. And then they verified the various issues that would affect the different stakeholders of cloud computing to provide recommendations for the practitioners who would provide and manage this technology.
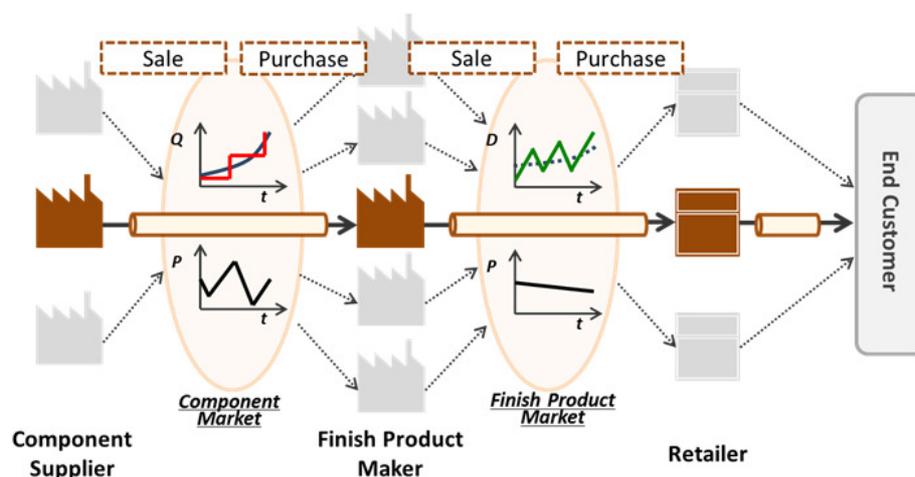
KEY COMPONENT MARKET OF HIGH TECH INDUSTRY

FIGURE 1: Target SC of High-tech Industry

Target SC is composed of key component supplier, finish product maker, and retailer as described in Figure 1 and each SC player prepares his production/sales plan for the long-term span in high-tech industry. One of the most important activities that determine the performance of the SC is the decision making on bargaining contract between supplier and buyer relationship. If there is no coordination mechanism that can help to align the different objectives of SC players, the efficiency of SC players and the SC-level competitiveness might decline radically.

Market demand uncertainty

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Variation vs. Fluctuation

In the research, we define market demand model using sine curve as Figure 2. The term 'variation' indicates the direction of change and its slope market demand change, and 'fluctuation' is expressed by the distance from the mean of market demand.
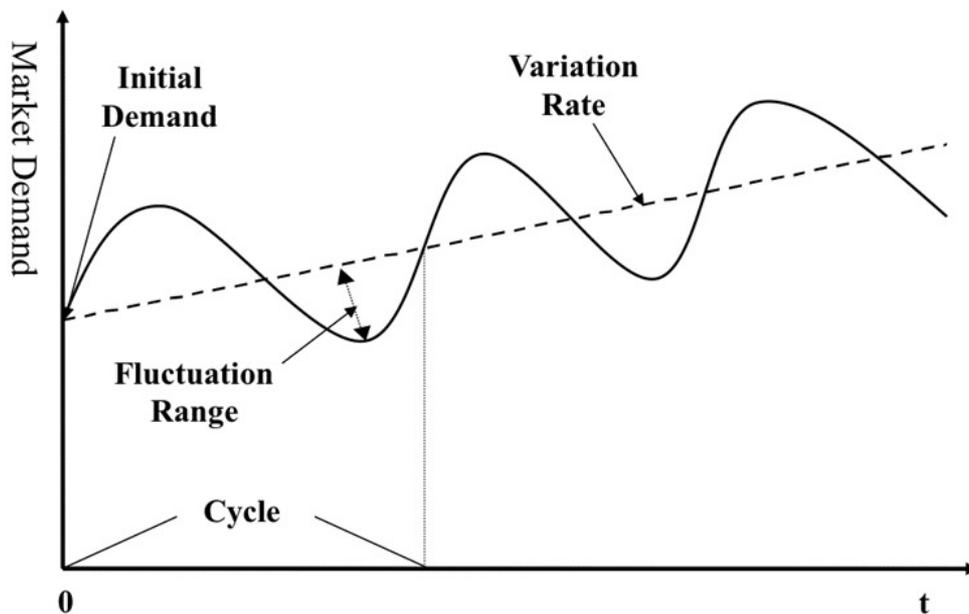

FIGURE 2: Market Demand Model (Ryu et al, 2009)

$$MarketDemand = InitialDemand + DemandVariationRate \times$$
$$(Time) + DemandFluctuationRange \times Sin\left(2\pi \times \left(\frac{Time}{VariationCycle}\right)\right) \tag{1}$$

CLOUD-BASED SCM SERVICES

IT system structure of the Cloud-based SCM Services is briefly shown in Figure 3. It has three layers, which are data storage layer, common-information processing layer and co-work operation layer. At the lowest layer of data storage, for example, planning and execution data is synchronized automatically in real-time manner. And SC partners (component supplier, finish product maker and retailer) join the system as SaaS user. In the proposed services, 'Forecasted Demand Deployment' and 'Potential Risks Evaluation' are two major features of Cloud-based SCM Services and we briefly show the details of the services in the following.
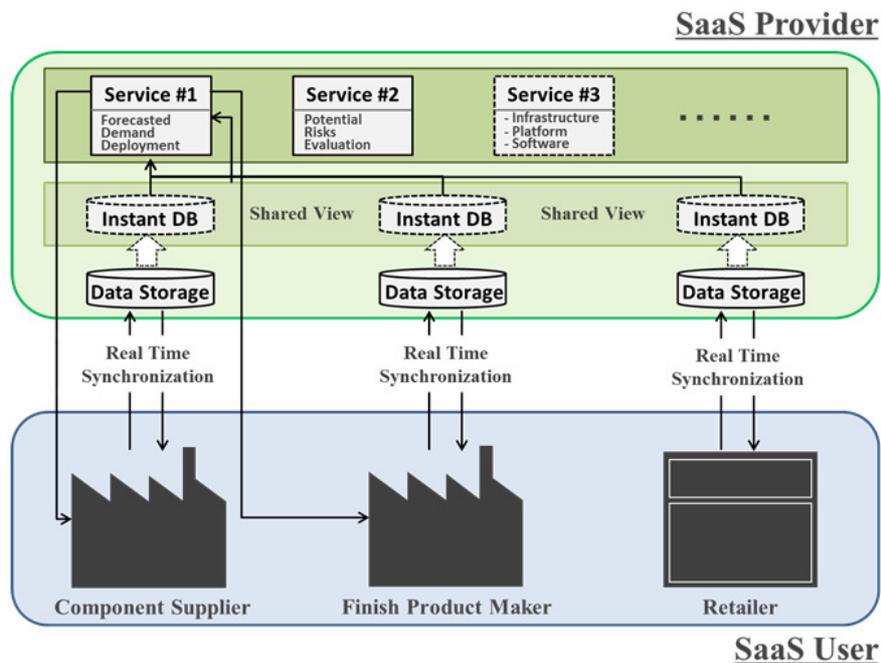

FIGURE 3: Cloud-based SCM Services

Forecasted Demand Deployment

In the proposed SCM Services, a third party organization (Cloud-based Services Provider) is responsible for forecasting market demand and deploying the requirements to each SC partners. It claims real-time information concerning each member's inventory status and lead-time and also the WIP conditions. For an example, the forecasted demand that component suppliers receive consists of the net expected requirement when all downstream net inventories are subtracted from the forecasted market demand for the target period.

Potential Risks Evaluation

Its objective is to achieve performance excellence in operational level by improving material flow and hedging the potential risks from sudden demand change in both key component and finish product market. To settle the reference price of long-term bargaining contract, potential

risks should be carefully evaluated during negotiation process between component supplier and finish product maker. Especially in the situations with high possibilities of demand change, the results from the contract is solely contributed to the smoothness of material flow and closely related with the expected profits of both players. In the research, we assume the terms of 'loss' and 'loss value' to evaluate the potential risks for the contracted reference price.
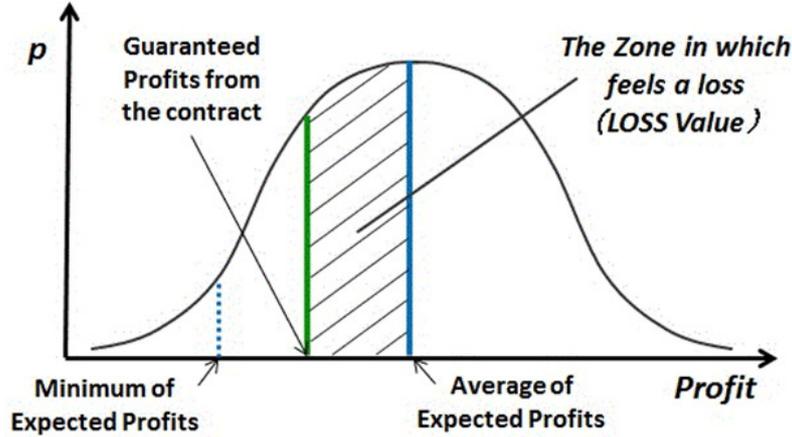

FIGURE 4: 'Loss value' and the Effect of Demand Change

The 'loss value' of component supplier and finish product maker is calculated as the equations below. And the expected profit is evaluated by taking 'loss value' into consideration during the negotiation process.

$$LOSS_S(x) = \sum_{i=contract}^{forecast} f(x_i) \times P(x_i) \qquad (2)$$

$$f_S(x) = q_{Contract} \times (x - p_{Spot}) + q_S \times p_{Spot} - Cost_S \qquad (3)$$

$$LOSS_M(x) = \sum_{i=contract}^{forecast} f(x_i) \times P(x_i) \qquad (4)$$

$$f_M(x) = q_M \times p_M - \{ q_{Contract} \times (x - p_{Spot}) + q_M \times p_{Spot} \} - Cost_M \qquad (5)$$

$q_{Contract}$: the quantity of long-term bargaining contract
p_{Spot} : spot market price of key component
q_S : total amount of produced quantity by component supplier
$Cost_S$: total cost of component supplier
q_M : total amount of produced quantity by finish product maker
p_M : market price of finish product
$Cost_M$: total cost of finish product maker

Information of evaluated potential risks is delivered to both component supplier and finish product maker to consider the market demand uncertainty properly and to reach the improved settlement during the long-term procurement/delivery contract negotiation.

RESULTS AND CONCLUSIONS

Simulation results show whether the proposed SCM Services performs against various market uncertainty conditions. We compare the following three models that represent different service subscribing situation.

(1)   Simple model (no service subscription)

(2)   With loss consideration model (only 'Potential Risks Evaluation' subscription)

(3)   With coordinator model (both services subscription)

Figure.5 shows the profit distribution in three models with three cases of demand fluctuation, the low fluctuation (20%), medium price fluctuation (50%) and high price fluctuation (80%). The result identified that the performance improvement of a profit distribution could not be acquired only by single service subscription especially when the degree of demand fluctuation become high level.   Moreover, 'With coordinator model' have made a great effect on profit of both SC players and SC itself.
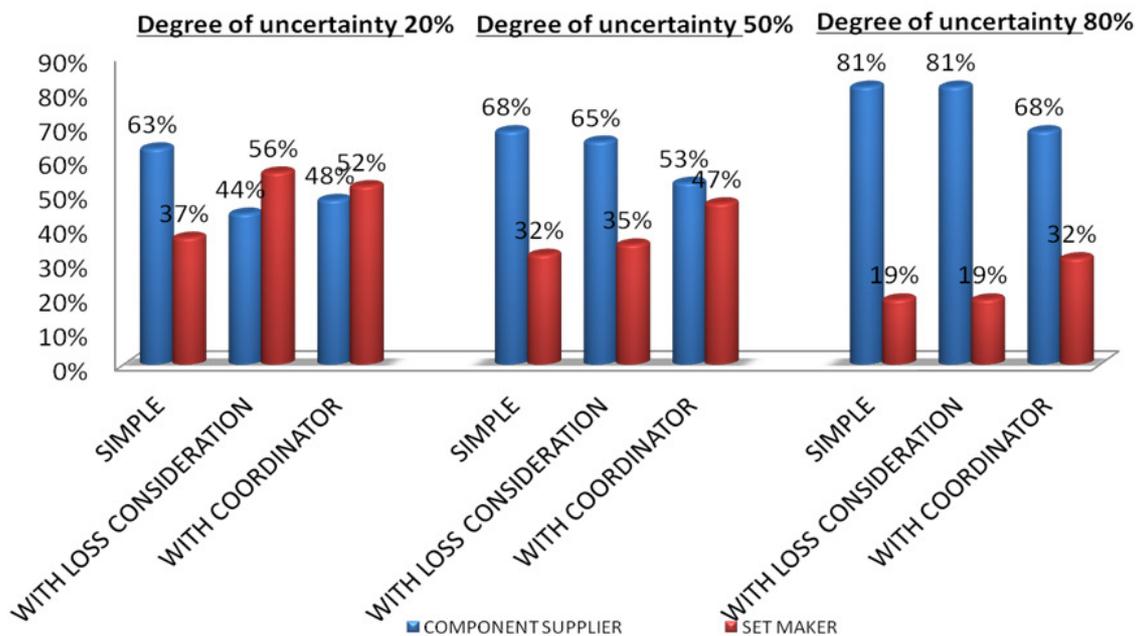

FIGURE 5: Profit distribution with Demand Uncertainty

In the research, we proposed Cloud-based SCM Services, which are 'Forecasted Demand Deployment' and 'Potential Risks Evaluation' for improving material flow of key component and finish product along the SC to distribute up-to-date market demand information and to calculate and provide evaluation value of potential risks. And also we briefly verified strengths and weaknesses of the proposed Cloud-based SCM Services by dynamic simulation with market condition of high demand uncertainty.

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