

## A Case Study: Supply Chain Uncertainties and Required Integration Based on Shared resources in the Chemical Industries

Abu Md. Saifuddoha, Md. Saiful Islam, Mahabubur Rahman, Kismot Abdul Quayum  
Khulna University of Engineering & Technology  
E-mail: saifs08@gmail.com

### Abstract

*One of the main themes in supply chain management is integration along the supply chain in order to improve performance. This paper contributes to a better understanding of what business conditions determine integrative practices. A framework is developed to investigate what level and scope of integration can be achieved in a supply chain dominated by shared resources, if the type and amount of uncertainty varies for different buyers. This framework is further explored in a case study of two colors manufacturing chemical industries and its six main buyers for one month through critical observations and interviewing techniques. Major findings obtained from the study are determining level of integration which is needed for different uncertainties for different buyer- supplier relationships based on shared resources of chemical industries.*

**Keywords:** Supply Chain, Integration, Buyer-supplier relationship, Shared resources, Uncertainty.

### 1. Introduction

The fundamental value of supply chain management for business improvement is widely acknowledged [3], [2], [4]. In theory, SCM means a proactive relationship and integration among various tiers in the chain [5]. An important idea seems to be that integration within and across firms is a pivotal element of supply chain management [6], [1]. Shared network resources are resources (product or process oriented) that are used by a supplier in the network for more than one buyer. Here, buyers competing for the resources seem to be one of the main barriers in achieving integration. This paper focuses on the type and level of integration that is achievable with each buyer if the supplier's capacity is shared.

### 2. Literature Review

#### Integration and integrative practices

From the SCM literature, it is clear that integration is closely associated with performing activities in several areas in co-operation with other organizations in a chain. Joint activities can be developed in different areas. This is labeled as the scope of integration: the number of supply chain areas in which cooperation is developed. Furthermore, this paper distinguishes four logistical areas as separate dimensions of the scope: flow of goods, planning and control, organization, and flow of information (see Table 2.1) [9], [7], [8], [10].

**Table 2.1** includes examples of Integrative practices within the four logistical areas.

| Dimension           | Examples of integrative practices                                           |
|---------------------|-----------------------------------------------------------------------------|
| Flow of goods       | Packaging customization, common containers, vendor managed inventories(VMI) |
| Planning & control  | Joint forecasting and/or planning, multilevel supply control [11]           |
| Organization        | Partnership, quasi-firm [13], virtual firm [4],JIT II [12]                  |
| Flow of information | Sharing production plans, EDI, internet, barcoding                          |

The level of integration can be described [14] as to what extent an integrative activity is developed. The level of integration applies to each of the areas presented under the scope.

### Classification of Uncertainty

In order to distinguish between the different kinds of risks, the sources of uncertainty need to be separated into two different constructs:

1. Endogenous uncertainty: The source of uncertainty/risk is inside the SC and can lead to changing relationships between focal firm and suppliers, the most notable kinds are market and technology turbulence.

Market turbulence: Market turbulence is likely to arise from the hetero-genetic and rapid changes in the composition of customers in the market and their preferences [15]. Market turbulence can also be caused by mergers or acquisitions. If a supplier is acquired by another company or the divestiture of a certain division occurs, this can result in delivery or quality problems.

Technological turbulence: Technological turbulence refers to the degree to which technology changes over time within an industry and the effects of those changes on the industry [16]. Technological turbulence arises from changes in the underlying technologies of products or services and their rates of obsolescence [15].

Endogenous uncertainty can be reduced with a proper and proactive relationship with a supplier (using methods like information sharing, relationship development, joint reviews, etc.) [17].

2. Exogenous uncertainty: The source of uncertainty/risk is from outside the SC. Possible disruptions can be classified as long-term uncertainties (e.g. raw material/final product unit price fluctuations, seasonal demand variations) and short-term uncertainties (cancelled/rushed orders, equipment failure, etc.) [18], while those risks can be classified based on their likelihood and impact on business [19].

Our proposed classification of exogenous uncertainty is novel by virtue of its distribution of risk on the probability distribution of its impact:

1. Continuous risk: Events where the costs of potential changes are continuous in nature and relatively easy to predict (example: changes in raw material prices). For such risks, a calculation of the effect of a certain price increase on profit margins can be made and different insurance instruments can be arranged in advance [23].

2. Discrete events: This category consists of low-likelihood, high-impact events which can be classified as terrorism, the spread of diseases, natural disasters [20]. These are often hard to predict and their consequences can be large yet hard to measure.

While endogenous uncertainty can be measured with precise (and previously validated) questionnaires, the exogenous uncertainty is harder to estimate.

### Uncertainty, shared resources and integration

A number of authors have explored the influence of uncertainty on integration in the supply chain. Three sources of uncertainty: customer demand, manufacturing and supply, control system [21], [10], [22].

The level of integration needed depends largely on the amount of uncertainty within the supply chain. In this paper, it is discussed the impact of the different kinds of uncertainty on the allocation of capacity and the need for integration in a supply chain (see Table 2.3).

**Table 2.3A** framework for integration in case of shared resources and different levels of uncertainty

| SC uncertainty                      | Impact                                                                                                    | Integrative practices                                                                                                                                                                            |
|-------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Low-volume, low mix/specification   | Necessity to integrate is absent                                                                          | Simple ordering procedures (continuous replenishment, quick response), working together in optimizing the control of inventories (e.g. Vendor Managed Inventories), physical flow (e.g. Kanban). |
| High-volume, low mix/specification  | Supplier has difficulty in capacity planning, buyers are reluctant to future commitments                  | Stocks, practices to improve physical flow                                                                                                                                                       |
| Low-volume, high mix/specification  | High obsolete risks, capacity requirements stable, broad scope and high level of integration is necessary | Capacity reservation or buyer-focused operations enables broad scope and high level                                                                                                              |
| High volume, high mix/specification | Stocks and capacity reservations are not feasible options, shared resources as important barrier          | Information exchange crucial, supplier orchestrates the different links with buyers                                                                                                              |

However, it is important to know what products have to be produced (the specification and the mix) and how much capacity needs to be planned or reserved (volume).

### 3. Research Methodology

#### Introduction to the case study

The suppliers under study are relatively small part of two different large multinational color manufacturing companies named Berger paints and TAJ MG. Berger paints chemical industry which is situated in Savar, Dhaka and the Toyo Ink and Chemicals Bangladesh Limited is situated 83 Rajashan, Savar, and Dhaka-1340. The supplier was studied during a period of 1 month, with about two site visits. Both the length of the period and the use of different methods, interviews with different persons from various departments and the combination of qualitative and quantitative data made validation of data possible.

#### Supply characteristics

Raw materials are picked from the warehouse. These raw materials are mixed according to the recipe. Supply uncertainty is thus practically absent. Planning is based on monthly forecasts from sales (replenishment orders) and actual customer orders. Still, the delivery reliability is roughly 95%. Demand is lumpy and one-off for most buyers. Uncertainty comes into being through both the specification of the product, the moment of ordering and the amount asked for. For the purpose of clarity, it is restricted itself to the relationship of the pigment supplier and the six largest buyers of their pigments of two different color manufacturing industries. Table 4.1 contains a summary of their general characteristics.

### 4. Data Collection and Analysis

The supply chain uncertainty as experienced by the pigment supplier for each link is summarized in Table 4.2. The levels of uncertainty are based on the numbers in Table 4.1 and the regularity in orders as well as assessments from the planners and sales people.

**Table 4.1** Characteristics of the six main buyers under two different paint industries

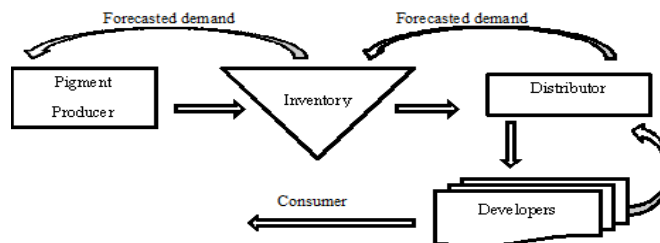
| Name of industries              | Berger Paints<br>(Berger Chemical industries) |                                   |                 | TAJ MG<br>(Toyo Ink & Chemicals Bangladesh limited) |                 |                                     |
|---------------------------------|-----------------------------------------------|-----------------------------------|-----------------|-----------------------------------------------------|-----------------|-------------------------------------|
| Topics                          | Developers                                    | Domestic Appliances               | Compoundin<br>g | Packaging I                                         | Packaging II    | Garment                             |
| Product life-cycle              | 3 years—10 years                              | 3 months—few years                | 2.5–3 years     | 2.5–3 years                                         | Long            | Long                                |
| Order cycle                     | 1 week-3 weeks                                | Few days' — 1.5 week              | 10 days         | Project                                             | <1 week         | <1 week                             |
| Sourcing policy Relationships   | Single More than 5 years                      | Single More than 5 years          | Dual 2 years    | Multiple More than 5 years                          | Single 10 years | Dual 10 years                       |
| Stocks Supplier                 | 3 months                                      | 3 months                          | 2 months        | Varies per project (no inventory risk)              | 2 months        | 6 months                            |
| Upstream                        | limited                                       | Very limited                      | Substantial     | N/A                                                 | 1 month         | 2 weeks                             |
| Obsolete stock                  | 1%                                            | 6%                                | 0%              | 0%                                                  | 0%              | 0%                                  |
| Customer-Order Decoupling-Point | Make-To-Order                                 | Make-To-Stock (for most products) | Make-To-Order   | Make-To-Order (delivery from stock)                 | Make-To-Order   | Make-To-Order (delivery from stock) |

**Table 4.2** Levels of uncertainty across the six buyers

| Name of industries       | Berger Paints<br>(Berger Chemical industries) |                     |             | TAJ MG<br>(Toyo Ink & Chemicals Bangladesh limited) |               |               |
|--------------------------|-----------------------------------------------|---------------------|-------------|-----------------------------------------------------|---------------|---------------|
| Types of uncertainty     | Developers                                    | Domestic Appliances | Compounding | Packaging I                                         | Packaging II  | Garment       |
| Uncertainty (short term) | Almost High                                   | Almost high         | Medium      | Low                                                 | Almost medium | Almost medium |
| Mix/specification        | Medium                                        | High                | Medium      | Low                                                 | Low           | Low           |
| Volume                   | Medium                                        | Medium              | Medium      | Low                                                 | Medium        | Medium        |
| Uncertainty (long term)  | High                                          | Medium              | Medium      | Very high                                           | Medium        | Medium        |

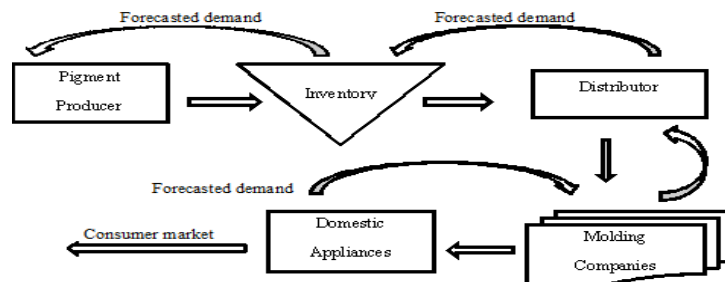
### Analysis for Developers

Despite the experienced uncertainty (high in specification, medium in volume), the level of integration remains high and the scope is narrow. According to Table 2.3, information exchange is crucial to enable the supplier to orchestrate the shared resources' capacity for the different supply links.

**Fig.1:** Flow of goods for Developers

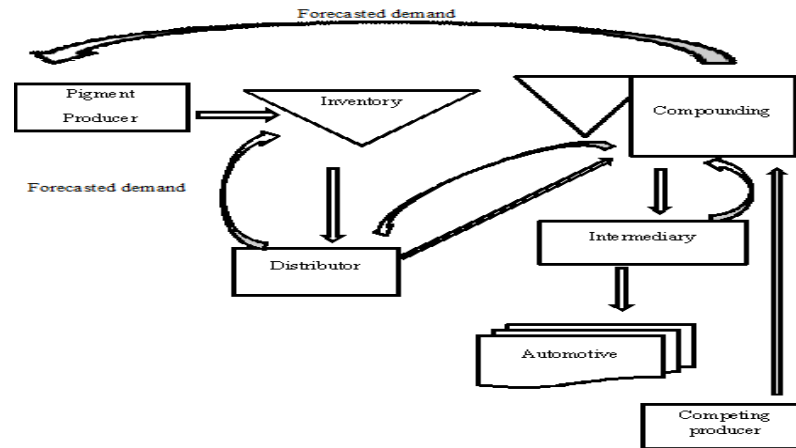
### Analysis for Domestic appliances

Despite the experienced uncertainty (high in specification, medium in volume), the level of integration remains high and the scope is narrow. According to Table 2.3, information exchange is crucial to enable the supplier to orchestrate the shared resources' capacity for the different supply links.

**Fig.2:** Flow of goods for Domestic Appliances

### Analysis for Compounding

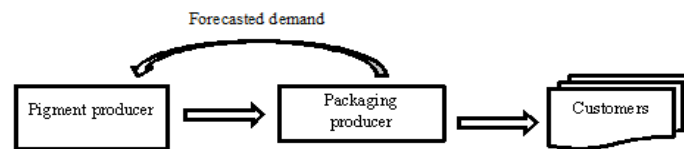
Given the medium level of uncertainty in volume and mix/specification, Table 2.3 suggests a somewhat higher level of integration. However, Compounding and the pigment producer both keep considerable stocks. Because of these stocks, uncertainty as experienced by the pigment producer is in fact low. Therefore, it is not surprising that the scope of integration is restricted (only exchange of information) and that the level of integration is not high. A better attuning of the level of stocks by means of an integrated planning and VMI is feasible in this situation and will reduce costs in the chain.



**Fig.3: Flow of goods for Compounding**

### Analysis for Packaging I

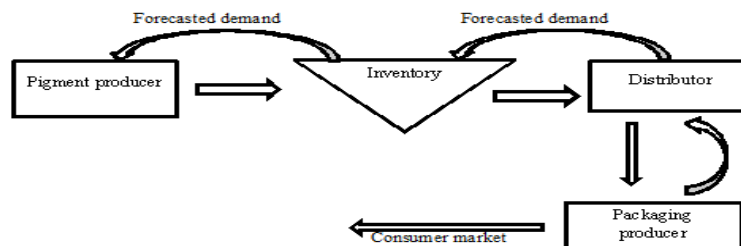
This link can be characterized as high uncertainty in the longer run, but low uncertainty in the operational stage of a project in the short run. Within each project there is hardly any uncertainty and sale of stocked items is guaranteed. The number of projects varies each year and the timing of projects is difficult to predict. Therefore, integration of activities is restricted to the projects themselves. Given the level of uncertainty within the projects, the narrow scope and the low level of integration are in line with Table 2.3.



**Fig.4: Flow of goods for Packaging I**

### Analysis for Packaging II

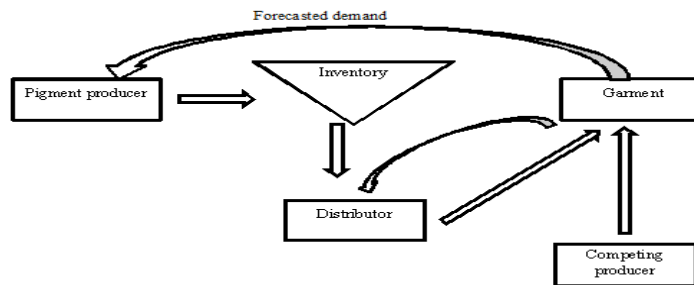
The activities of the pigment producer and Packaging II are not integrated at all. There is some uncertainty regarding the volume and timing of orders. If the buyer and supplier would decide to reduce their stocks, Table 2.3 suggests a higher level of integration to cope with the uncertainty in volume and timing. This reduction in stock levels might be achieved by sharing more information.



**Fig.5: Flow of goods for Packaging II**

### Analysis for Garment

Garment uses a dual sourcing policy with our pigment producer supplying 66% (see Fig.6). Due to this sourcing policy, there is some uncertainty with respect to timing and volume. The colors, however, are not often subjected to changes. The low level of integration and narrow scope seems appropriate.



**Fig.6:** Flow of for goods garment

## 5. Discussion

Here, this paper concentrates on supply chains that are dominated by shared resources: common capacity used for different supply chains. The paper develops a framework for the influence of uncertainty on the level and scope of integration, in case of shared resources. The findings in the case study are in line with what is expected, but more research across more different cases in different industrial sectors need to be performed to limit possible biases from studying only six supplier–buyer relationships in the color manufacturing chemical industry. Another area for further research is the level of performance associated with different levels of integration.

## 6. References

- [1]Christopher,M.,1998. *Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Service*, 2nd Ed. Financial Times/Pitman publishing, London.
- [2]Lysons,K., 2000. *Purchasing and Supply Chain Management*, 5th Ed. Pearson Education Ltd. Harlow, England.
- [3]Saunders,M.,1997. *Strategic Purchasing and Supply Chain Management*. Pitman Publishing, London.
- [4]Tan,K.C.,2001. *A framework of supply chain management literature*. *European Journal of Supply Chain Management* 7, 39–48.
- [5]Trkman, P., Stemberger, M., et al., 2007. *Process approach to supply chain integration*. *Supply Chain Management—An International Journal* 12 (2), 116–128.
- [6]New,S.J.,1996. *A framework for analyzing supply chain improvement*. *International Journal of Operations & Production Management* 16,19–34.
- [7]Ribbers,A.M.A.,Verstegen, M.F.G.M. (Eds.),1992. *Toege- paste Logistiek* (in Dutch). Kluwer Bedrijfs wetenschappen, Deventer, The Netherlands.
- [8]Romano,P., 2003. *Co-ordination and integration mechanisms to manage logistics processes across supply networks*. *Journal of Purchasing & Supply Management* 9 (5–6),119–134.
- [9]Van Donk,D.P.,2003. *Redesigning the supply of gasses in a hospital*. *Journal of Purchasing & Supply Management* 9 (5–6),225–233.
- [10]Childerhouse, P., Towill, D.R., 2002. *Analysis of the factor affecting the real- world value stream performance*. *International Journal of Production Research* 40 (15), 3499–3518.
- [11]Van der Vlist,P., Hoppenbrouwers,J.J.E.M., Hegge, H.M.H., 1997. *Extending the enterprise through multi-level supply control*. *International Journal of Production Economics* 53, 35–42.
- [12]Stock,J.R.,Lambert,D.M.,2001. *Strategic Logistics Management* 4th Ed. McGraw-Hill,Boston.
- [13]Lamming,R.,1993.*Beyond Partnership: Strategies for Innovation and Lean Supply*. Prentice Hall, New York.
- [14]Frohlich,M.T.,Westbrook, R., 2001. *Arcs of integration: An international study of supply chain strategies*. *Journal of Operations Management* 19,185–200.
- [15]Kandemir, D., Yaprak, A., et al., 2006. *Alliance orientation: conceptualization, measurement, and impact on market performance*. *Academy of Marketing Science Journal* 34 (3), 324–340.
- [16]Chatterjee, P., 2004. *Inter firm alliances in online retailing*. *Journal of Business Research* 57 (7), 714–723.
- [17]Ritchie, B., Brindley, C., 2007. *Supply chain risk management and performance: a guiding framework for future development*. *International Journal of Operations and Production Management* 27 (3), 303–322.
- [18]Gupta, A., Maranas, C., 2003. *Managing demand uncertainty in supply chain planning*. *Computers and Chemical Engineering* 27 (8), 1219–1227.
- [19]Hackett Group, 2007. *Dow Chemical Company: Supply Risk Management Process Is Key to Improving Safety and Security*.
- [20]Faisal, M., Banwet, D., et al., 2006. *Mapping supply chains on risk and customer sensitivity dimensions*. *Industrial Management and Data Systems*. 106 (6), 878–895.
- [21]Davis,T.,1993.*Effective supply chain management Sloan Management Review* 34 (4), 35–46.
- [22]Mason-Jones,R.,Towill,D.R., 1998. *Shrinking the supply chain uncertainty circle*. *The Institute of Operations Management and Control* 24 (7),17–22.
- [23]Aggarwal, P., Ganeshan, R., 2007. *Using risk-management tools on B2Bs: an exploratory investigation*. *International Journal of Production Economics* 108 (1–2), 2–7.