New Product Introduction and Supplier Integration in Sales and Operations Planning: Evidence from the Asia Pacific Region

Abstract

Purpose: This paper investigates the implementation and performance benefits of Sales and Operations Planning (S&OP) within organizations in Asia Pacific.

Design/methodology/approach: A case study method was used, with two companies selected. The first company had recently commenced S&OP and applied it to facilitate New Product Introduction, while the second had integrated its supplier into an existing S&OP program. Supply chain performance data was collected and analyzed in the context of an S&OP maturity framework.

Findings: Both cases show significant improvements in supply chain performance. In one case, the implementation of a common form of S&OP resulted in a 67% reduction in order lead time for newly introduced products. The second case demonstrated a 30% reduction in inventory levels and a 52% improvement in forecast accuracy through more advanced S&OP processes.

Research limitations/implications: This paper studies just two companies and is not intended to be representative of outcomes at all companies implementing S&OP. Further studies are required for a more generalized picture of S&OP implementations in the Asia Pacific region to emerge.

Practical implications: The findings illustrate the potential quantitative benefits of adopting S&OP and the circumstances under which these benefits may be achieved. The results are also supportive of the notion of a maturity model for S&OP implementations.

Originality/value: This paper strengthens the link between practitioner and academic literature by providing empirical evidence of the benefits of S&OP. Furthermore, the findings are derived from the Asia Pacific region for which there have been few academic studies on S&OP to date.

Key words: Sales and operations planning, new production introduction, supplier integration

1. Introduction

Sales and Operations Planning (S&OP) can be defined as the set of business processes and technologies that enable an enterprise to respond effectively to demand and supply variability with insight into the optimal market deployment and most profitable supply chain mix (Muzumdar and Fontanella, 2006). S&OP can also be described as a form of internal collaboration, in which a cross-functional team reaches consensus (Slone et al., 2013). S&OP is frequently enabled by Enterprise Resource Planning (ERP) systems (Affonso et al., 2008) in conjunction with other advanced planning systems (Jonsson et al., 2007) that are used as tools to co-ordinate the supply chain.

The benefits claimed for S&OP are numerous and include revenue improvements ranging from 2% to 5% and inventory reductions of between 7% and 15% (Cacere et al., 2009). S&OP practitioners have also reported: higher customer satisfaction; balanced inventory across product lines and customers; more stable production rates and higher productivity; more cooperation across the entire operation; better forecasting (Keal and Hebert, 2010); more efficient decision making; and a greater focus on longer term horizon (Smits and Kipala, 2012). McCormack and Lockamy (2005) found via survey-based research a significant relationship between internal horizontal mechanisms in S&OP and firm performance.

Despite the many insights and success stories reported in the literature regarding S&OP strategies, other organizations have had limited success owing to a variety of factors such as: a lack of process ownership; misalignment between stakeholders; functional silos in the organization; flawed performance management metrics; too many stock-keeping units; and forecasting errors (Iyengar and Gupta, 2013; Slone et al., 2013; Wagnar et al., 2014).

Therefore, for organizations to realize the benefits of S&OP and reduce the risk of failure, it is important to develop a more comprehensive understanding of how S&OP needs to be implemented. This need has been addressed widely in the practitioner literature (such as Milliken, 2008; Iyangar and Gupta, 2013) but features little within academic research publications (Tuomikangas and Kaipia, 2014). Furthermore, relatively few studies have been published which investigate the implementation of S&OP in the Asia Pacific region when compared to the number of studies in other regions. This is evident in Tuomikangas and Kaipia (2014)'s synthesis of the S&OP literature, in which out of the 99 academic and practitioner papers reviewed, less than 5% were authored by Asia-based researchers and empirical evidence of the benefits of S&OP is particularly rare. Considering that Asia accounts for 38.9% of the world's manufacturing output (UNIDO, 2014), it is surprising that the role that S&OP has played in Asian manufacturing is very much unexplored.

This paper thus aims to describe a study of the implementation of S&OP within organizations in the Asia Pacific region. In particular, evidence concerning the performance benefits of S&OP implementation was sought alongside an exploration of S&OP practices and the link between them and the maturity of the S&OP implementation. The focus of this paper is not so much on NPI and supplier integration (which are broad research topics in themselves), but rather how S&OP can be adapted to incorporate suppliers' inputs and to facilitate the introduction of new products. The next section of the paper presents a literature review in order to establish the theoretical context of

S&OP implementation in the Asia Pacific region and refine the issues to be researched. A case study approach was adopted for the research and the research design is explained in section 3. The case findings are presented in section 4 with further cross-case analysis and discussion in section 5. The conclusions and recommendations for further research are presented in section 6.

2. Literature Review

This section begins by establishing the role of S&OP within the general context of supply chain management and logistics. The relationships between S&OP and supply chain integration and firm performance are described with particular emphasis on the enabling role of S&OP for both internal integration and external integration within a supply chain. S&OP implementation is then considered as a continuously developing capability for the firm and maturity models of S&OP implementation are discussed. Key relevant studies on supply chains within the Asia Pacific region are reviewed and the section concludes with a summary which highlights the issues which are the focus of this study.

Thomé et al. (2012) and Tuomikangas and Kaipia (2014) have conducted comprehensive literature reviews on S&OP and the reader is referred to their papers for an overview and categorization of previous research on S&OP in the literature. As Thomé et al. (2012) noted, different researchers place S&OP at different time horizons along the supply chain. One group of researchers associate S&OP with the longest-term planning level in a manufacturing planning and control (MPC) system and thus S&OP deals with the long-term management of capacity. Other authors position S&OP at the tactical level (Feng et al., 2008, Wang et al., 2011), which is also the definition adopted in this paper.

A well-known application of S&OP is in the introduction of new products into the supply chain. New Product Introduction (NPI) time refers to the time required to "make product improvements/variations to existing products, or to introduce completely new products" (Jayaram et al., 1999). However in this paper, we are more focused on the fulfillment phase of NPI rather than the entire new product development cycle. One of the greatest challenges in planning demand for new products is that since there is no historical demand data, the same forecasting techniques used for regular-turn stock-keeping units (SKUs) cannot be relied upon (Lee, 2002). New product introductions are also hindered by cross-functional problems (Slone et al., 2013), namely: too much obsolete inventory, excessive product complexity, poor forecasts and ineffective product management. There have been numerous practitioner-based papers that report that S&OP can help overcome this difficulty. S&OP has been credited with improving the success of new product launch commercialization by 20% (Cacere et al., 2009). S&OP had also resulted in faster introduction of new innovation at British American Tobacco in Europe (Godsell et al., 2010).

A study by Benedetto (1999) based on data from nearly 200 product launches found that the most successful new product launches were characterized by use of cross-functional teams with the involvement of the logistics function, and that on-time delivery played a somewhat significant part ($p<0.10$) in successfully launches when compared to unsuccessful launches. On the other hand, misalignment between the new product development and the supply chain can lead to (partially) failed product launches due to a lack of product availability through insufficient supplier, production and/or distribution capacity (Van Hoek and Chapman, 2007).

Most S&OP models are internal to a company, though past research in operations management suggests that intra and inter-firm integration may have a positive effect on firm performance (Stank et al. 2001 , Droge et al., 2004; Zailani and Rajagopal, 2005; Collin and Lorenzin, 2006; Poler et al., 2007). Other researchers have also proposed various degrees of integration within the traditional S&OP framework. For instance, Affonso et al. (2008) proposed a wider S&OP model that also includes the supply element that provides a better support for integration not just inside the company, but also for integration of the company within its greater supply chain. Smith et al. (2010) presented a case study on how two trading partners can link their S&OP processes via the Collaborative Planning, Forecasting & Replenishment (CPFR) framework to create a collaborative, synchronized end-to-end supply chain. Wang et al. (2011) also proposed a new S&OP framework to integrate four supply chain stages of demand, purchasing, production and transportation.

Such extensions of the traditional S&OP model have given rise to several attempts to classify S&OP implementations according to the level of maturity (Lapide, 2005; Grimson and Pyke, 2007; Cacere et al., 2009; Wagner et al., 2014). In particular, Grimson and Pyke (2007)'s framework identifies 5 stages of maturity in S&OP integration. This framework grades firms across five dimensions, comprising business processes (meeting and collaboration, organization and performance measurements) and information processes (information technology and S&OP plan integration). Stage 1 of the framework is the most basic, in which S&OP is not adopted. Stage 2 ("Reactive S&OP") involves senior management in discussing sales and operations issues. However this is mainly in the context of financial goals, rather than for the purpose of integrating plans or centralizing information, as is the case in Stage 3 ("Standard S&OP"). In Stage 4 ("Advanced S&OP"), suppliers and customers participate in scheduled meetings as part of a formal S&OP team. Planning is concurrent rather than sequential and performance is measured for new product introductions (NPI). Finally, in the most mature form of S&OP (Stage 5 "Proactive S&OP"), meetings become event-driven and there is full integration of plans and between ERP, accounting and forecasting systems. In this paper, Grimson and Pyke (2007)'s framework has been chosen as the main reference as it is the seminal academic paper in the literature on S&OP maturity models.

Table 2.1: S&OP Maturity Model (Adapted from Grimson and Pyke, 2007)

	Stage 1: No S&OP Process	**Stage 2: Reactive**	**Stage 3: Standard**	**Stage 4: Advanced**	**Stage 5: Proactive**
Meetings & Collaboration	None	High level	Executive S&OP meetings	Supplier/ customer participation	Event-driven
Organization	None	No formal S&OP teams	No dedicated S&OP roles	Formal S&OP teams	Company-wide S&OP
Measurements	None	How well operations meet sales plan	Stage 2 plus forecast accuracy or lead time	Stage 2 plus new product introduction	Stage 4 plus profitability
Information Technology	Spreadsheets, no consolidation	Spreadsheets, some consolidation	Centralized information with ERP	Standalone S&OP and ERP systems	Integrated S&OP with ERP
S&OP Plan Integration	No formal plan	Sales driven	Some integration, uni-directional constraints	Highly integrated, bi-directional constraints	Seamless plans

A key finding of Grimson and Pyke (2007)'s investigation is that none of the 15 manufacturing firms that they studied was judged to have fully reached stage 4 or stage 5 maturity in the adoption of S&OP. Similarly, AMR Research (later Gartner) reported that 85% of 182 companies studied in 2009 have an S&OP process, but the majority (67%) of these companies are in Stage 1 or 2 of a 4-stage maturity model (Barrett and Uskert, 2010).

Internal collaborations (such as Stage 1 to 3 S&OP) facilitate close interactions in day-to-day operations, whereas in external collaborations, trading partners share the necessary intelligence on order patterns, planned product promotions (which may include NPI), and service feedback (Stank et al., 2001). When viewed from the perspective of involvement of participants, Stage 4 and 5 S&OP can thus be represented as occupying the overlapping region between internal and external supply chain collaborations (which is summarized in Figure 2.1).

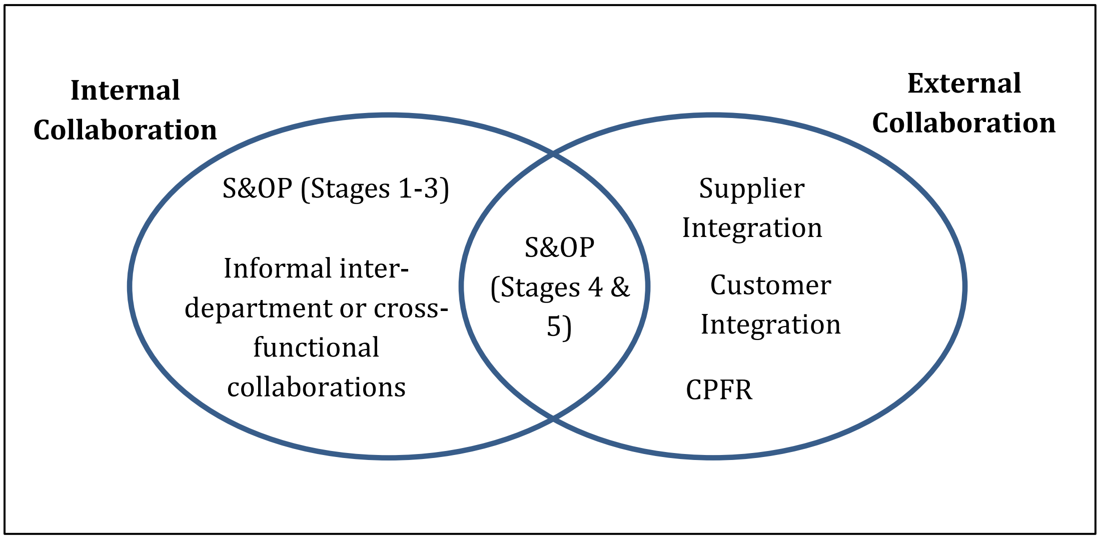

Figure 2.1: S&OP within the Supply Chain Collaboration Context

As Figure 2.1 shows, supplier integration can in theory be implemented independently of S&OP. Yet, the role that supplier integration can play in S&OP is promising and there is also some evidence from academic literature that such mature S&OP systems can result in better performance. Thomé et al. (2014) found based on data from the International Manufacturing Strategy Survey of 725 respondents worldwide that supplier integration had an amplifying effect on the impact of internal S&OP. As such Thomé et al. (2014) concluded that firms should pursue supplier integration simultaneously with the deployment of internal S&OP practices. Stank et al. (2001)'s earlier research of 306 companies similarly revealed that collaboration with external entities increases internal collaboration. Therefore when best practice firms combine internal and external collaborative practices (whether via Stage 4/5 &OP or otherwise), they are able to reap synergistic benefits.

The main outcome in most papers in the literature was the cross-functional integration of planning activities and few have analyzed the actual impact of S&OP on the performance of the firm (Thomé et al., 2012). One of these is that of Nakano (2008), who found from a survey of 22 Japanese companies that while internal collaborative forecasting and planning have positive effects on relative logistics and production performance, external collaborative forecasting and planning were not found to have a significant effect on performance. Wang et al. (2011) tested their advanced sales and operations planning model on a Taiwan TFT-LCD TV company that owned multi-sites in Asia. However, their research focused on numerical modeling, rather than actual implementation outcomes of advanced S&OP at the target company. It also did not compare the theoretical optimized results against an actual "as-is" baseline.

Apart from the exceptions noted above, there are few other examples of studies on S&OP in the Asian context and at least one group of researchers attribute this to regional/cultural factors. Zailani and Rajagopal (2005) investigated supplier and customer integration strategies in US and East Asian companies. Their findings showed that East Asian firms "emphasize on internal control primarily to reduce costs" while US firms emphasize "operational integration of physical process flows between a company and its suppliers and customers". This suggests that, compared to their global counterparts, East Asian manufacturers are less inclined towards collaborative manufacturing practices. This finding seemed to be corroborated by Handfield and McCormarck (2005), who found that less than 10 percent of companies in China have formal S&OP processes. Chinese suppliers generally have immature cross-functional and cross-company planning capabilities. They show a lack of planning between functions such as marketing and purchasing. Even in Chinese companies with formal S&OP processes, forecasts typically are aggregated across all product lines, rather than at SKU level.

The review of literature has uncovered previous studies that proposed competing yet somewhat similar S&OP maturity frameworks. Studies on the impact of S&OP were largely via indirect or qualitative observations. Direct evidence on the effectiveness of S&OP via measurable supply chain performance is either scarce or not publicly available. As Noroozi and Wikner (2013) suggested, S&OP has largely been developed by practitioners in industry and despite the growth of academic literature about this subject in recent years, the gaps between industrial needs and academic research still exist (Noroozi and Wikner, 2013). As such, this study investigates the implementation of S&OP within organizations in the Asia Pacific region with particular focus on identifying actual performance benefits associated with S&OP implementation and the potential link between these benefits and the maturity of the S&OP implementations in those organizations being studied.

3. Research Methodology

3.1. Research Objectives

The research objectives can be summarized as follows:

- To carry out an empirical investigation of successful S&OP implementations in the Asia Pacific region
- To evaluate actual (rather than theoretical or self-reported) improvements in the supply chain performances of these representative companies that have introduced S&OP and understand the context in which these improvements were achieved
- To seek evidence that supports the link between benefits and the maturity of S&OP implementations, particularly when a supplier is integrated into the process

3.2. Method Selection

During the design phase of this empirical research, the survey and explanatory case study methods were both explored.

There has been a number of studies on S&OP using the survey method, for example McCormack and Lockamy (2005), Slone et al. (2013) and Thomé et al. (2014). For this paper, a preliminary survey was designed and conducted to provide background for the study. Out of 80 representatives of targeted companies invited to participate, 30 responses were received, of which 25 were usable. The pool of invitees (and thus respondents) was very small as it was intentionally limited to those who were sufficiently knowledgeable about S&OP to participate in an in-depth questionnaire and whose companies have implemented S&OP. The challenge of this approach thus became obvious. Additionally, the survey-based approach to S&OP research also has the limitations on the measures used and the usage of self-reported results instead of those from an outside observer (Tuomikangas and Kaipia, 2014). A large scale survey would also not provide evidence as to how firms can achieve process improvements in forecasting and planning (Nakano, 2008), which is one of the objectives of the current study. Nonetheless, the feedback from respondents in the exploratory survey indicated that S&OP implementations in their company seldom involved suppliers nor were they designed with NPI in mind, as illustrated in Figures 3.1 and 3.2. It is worth noting that the involvement of external participants and the application to new product introduction are both features of “Advanced S&OP” according to Grimson and Pyke (2007)’s maturity framework.

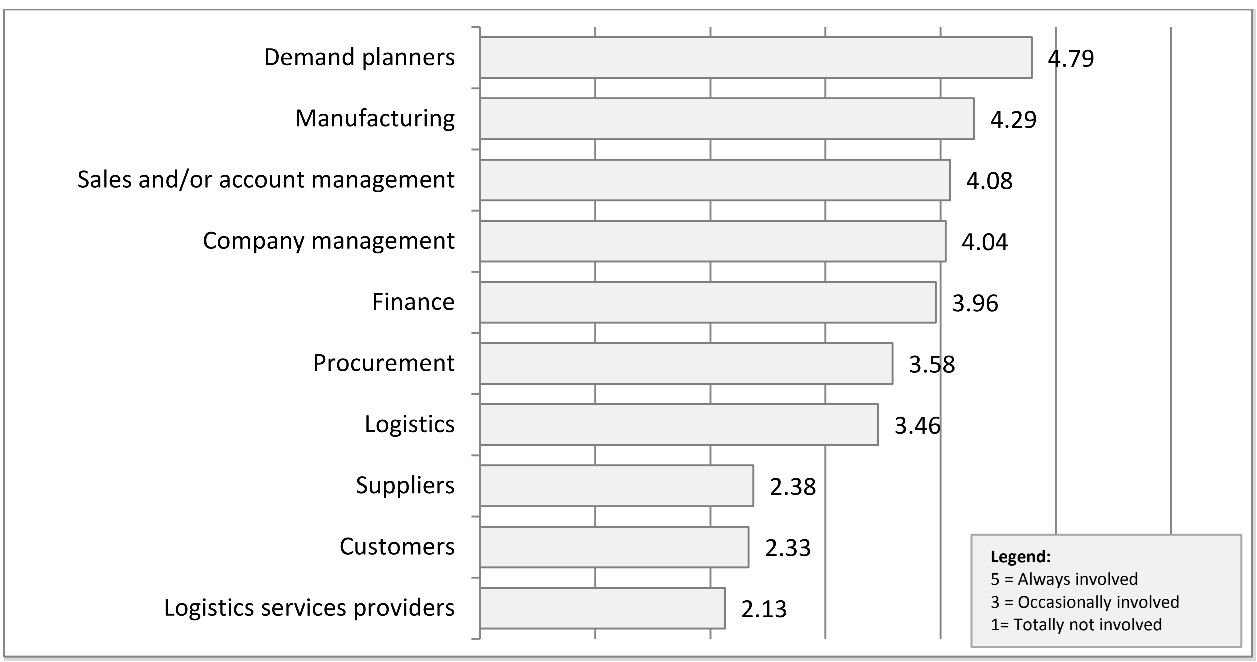

Figure 3.1: Participants’ Level of Involvement in S&OP among Asia-Pacific Companies (N=25)

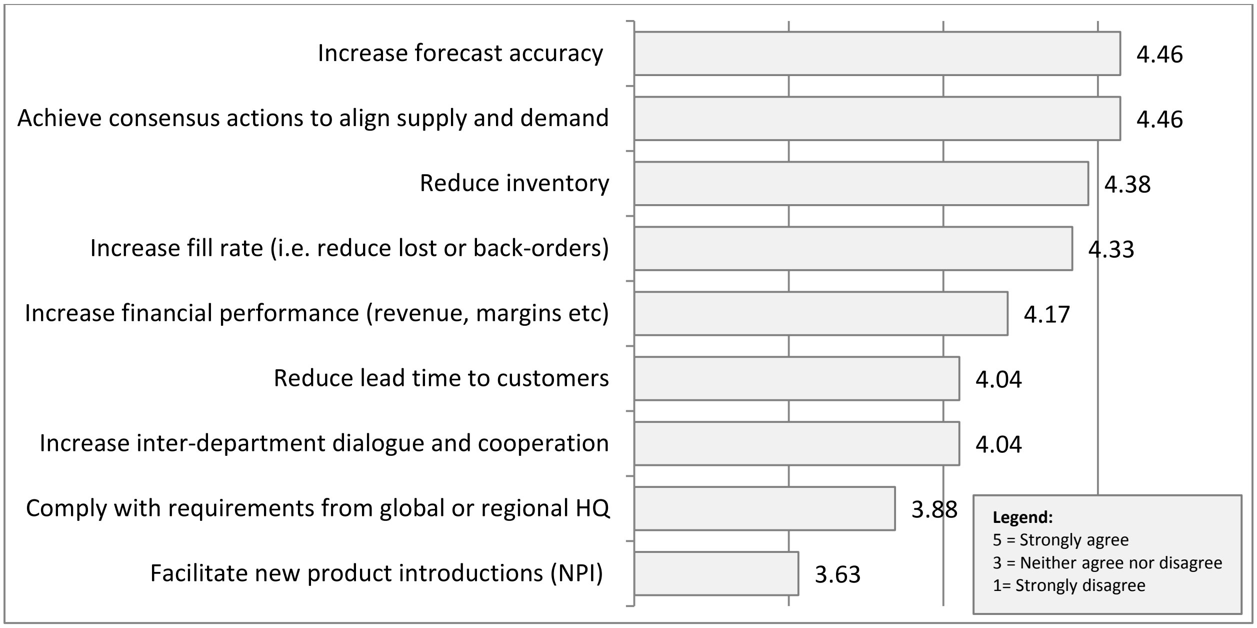

Figure 3.2: Motivations of Implementing S&OP among Asia-Pacific Companies (N=25)

Like the survey method, a case study is an empirical inquiry of a contemporary phenomenon in its real world context. As Yin (2013) noted, although case study research is often seen as exploratory in nature, it is far from being only an exploratory strategy, but can be explanatory. The case study method is not without its shortcomings, one of which is an apparent inability to generalize from a single case study beyond theoretical propositions, although multiple cases are be used to draw a single set of "cross-case" conclusions (Yin, 2013). Despite this limitation, the use of case studies in S&OP research is not unprecedented (Collin and Lorenzin, 2006; Jonsson et al., 2007; Oliva and Watson, 2011) and the majority of these are "single-case" in nature. In their synthesis of S&OP literature, Tuomikangas and Kaipia (2014) thus proposed case studies with multiple perspectives to deal with the complexity of the S&OP phenomenon.

For these reasons, the case study method was selected for this research with, initially, two cases in the study. A two-case study approach can help develop convergent evidence (Yin, 2013) to strengthen the validity of the propositions that S&OP can result in significant improvements in supply chain performance and that more mature S&OP processes can lead to larger gains (Lapide, 2005; Grimson and Pyke, 2007; Cacere et al., 2009; Wagner et al., 2014; Thomé et al., 2014). Furthermore, the use of two cases also enables insights into the relative maturity of the S&OP processes at both target companies.

3.3. Target Selection

Data on relevant supply chain metrics was collected between 2012 and 2013 from two large unrelated multinational companies. Both companies' Asia Pacific operations are headquartered in Singapore and have extensive distribution activities throughout the region.

Company A (name withheld) is a major manufacturer of fire protection systems under multiple product groups, such as fire detection systems, sprinklers and valves. Products are typically manufactured in company-owned plants around the world or by contracted manufacturing partners. The Singapore distribution center stocks products for distribution in Singapore and within South East Asia. Product lifecycles (from launch to withdrawal from the sales channel) are generally long, exceeding 3 years.

The second target company, Company B (name withheld), provides a wide range of software, hardware and embedded technologies for the data center industry. Company B's customers are mainly enterprise-level IT organizations, who use these products to monitor, control, and manage their geographically dispersed IT infrastructure more efficiently. Company B sells products under its own brands and also manufactures on behalf of original equipment manufacturer (OEM) customers. Its Asia Pacific hub is based in Singapore, from which the region is served from a regional distribution center (RDC).

These two companies were selected for the case study as they have demonstrated capabilities in implementing full S&OP cycles. Both companies also face challenges similar to those other companies operating in multiple markets in the Asia Pacific region. Each of them manages a truly international supply chain, in which manufacturing, warehousing and final distribution activities are all performed in different countries. Yet, the Asia Pacific manufacturing industry is highly diverse and there is therefore not one "typical" supply chain. The two subject companies in the case studies offer contrasting firm characteristics such as product value, lifecycle, demand patterns and organizational maturity. These two companies are thus arguably suitably representative (and yet sufficiently different) cases in which an instructive set of cross-case analyses could be carried out.

Furthermore, "clean, current, and accurate data" is a key to successful S&OP (Muzumdar and Fontanella, 2006). Both of these target companies have reliable data collection and archival abilities, which would allow an analysis of how their supply chain performances have evolved over time. An assessment of the quality of data also found that data provided by these two companies was complete for the time period studied and did not require extensive cleansing.

Table 3.1 summarizes the two companies' product profiles and fulfillment strategies.

Table 3.1: Profile of Companies in Case Studies

Supply Chain and Selection Criteria	Company A	Company B
Product type	Fire protection equipment	Data center equipment
Product unit value	Wide range, from low to high	High (>US$1,000)
Lifecycle	Long (>3 years)	Short (1-2 years)
Demand variability	High	Medium
Fulfillment strategy	Fill from stock wherever possible, but large quantities may have to be backordered	Fill from stock
Key supply chain metric	Lead time to customers (from order to delivery)	Inventory level and forecast accuracy
S&OP stage	Recently started implementing a basic form of S&OP to facilitate new product introduction	Started S&OP 2 years ago and has evolved to a more mature state by involving key suppliers in the process
Enterprise resource planning and data warehousing system	SAP	SAP

Compared to Company A, Company B operates in a more dynamic and competitive industry. The product lifecycle of data center equipment is also shorter than that of fire protection systems. Thus, Company B faces slightly different supply chain challenges. Rather than lead time, Company B strives to lower its inventory levels and improve forecast accuracy owing to the higher cost of obsolescence.

Orders at Company A are so highly variable that it is often impractical to fill the majority of orders from stock, but lead time is minimized as far as possible for back orders (which occur quite frequently). Company B's product demand profile is less volatile, but it operates in an industry where downtime is seldom tolerated. As such, orders are usually filled from stock and inventory levels are maintained at as low as possible to meet a high targeted service level or fill rate.

At the time of the study, the two companies were also at different stages of their S&OP journeys. The first had recently adopted a common form of S&OP, while the second company had adopted S&OP for two years and subsequently decided to integrate its contract manufacturing partner into its S&OP program.

3.4. Data Collection

In the first phase of the study, "as-is" process flows were mapped out for both companies, with description on processes at each step. These were then compared and contrasted against the "new" process flows.

In the second phase, relevant performance data (prior to and after the planned changes to the processes) was obtained. The analysis focused on supply chain performance improvements *over* time for each company. Since the product characteristics and S&OP maturity of both companies were different, it would not be meaningful to benchmark supply chain performance *across* both companies.

Table 3.2 summarizes the list of information and data that were required to address the research objectives.

Table 3.2: Data Required for the Study

Case Study Company	Primary Data or Information	Relevance to Research Objective	Source of Data or Method of Collection	Comments
Both	Existing and new process flows	To describe qualitatively the changes in the process after the introduction of S&OP or Advanced S&OP	Semi-structured interview of company informants (demand planner or supply chain manager), flow charts	
Company A	Order quantities, order and dispatch dates (time series) for new products, prior to and after the introduction of S&OP	To measure improvements in order lead time for new products, after the introduction of S&OP	SAP data records	Order lead time can be derived from the difference between order and dispatch dates. Transportation lead time is outside the scope of this study
Company B	Inventory level, inbound receipts and outbound receipts at regional distribution center, demand quantity (time series) for the same SKU, prior to and after the introduction of S&OP	To measure improvements in inventory levels and forecast accuracy, after the introduction of Advanced S&OP	SAP data records, distribution center shipment records	Historical forecasts are not maintained once they become obsolete, thus forecast accuracy can be indirectly measured by discrepancies between inbound and outbound shipments at the distribution center

Primary data related to supply chain performance was extracted from ERP systems by the respective company informants. The data was checked for completeness, quality and consistency. Outliers were found to be very rare, except in one instance, in which the data point was discarded with justification. In some cases, subsequent normalization of data was performed (e.g. normalizing inventory to remove the bias introduced by non-stationary demand). Finally, tests of significance were also conducted, particularly when the number of data points in the time series post-implementation was low.

4. Case Study Findings

4.1. Case 1 – Internal S&OP as Applied to New Product Introduction

Figure 4.1 shows the typical flow of products from Company A's plants and suppliers to customers across South East Asia.

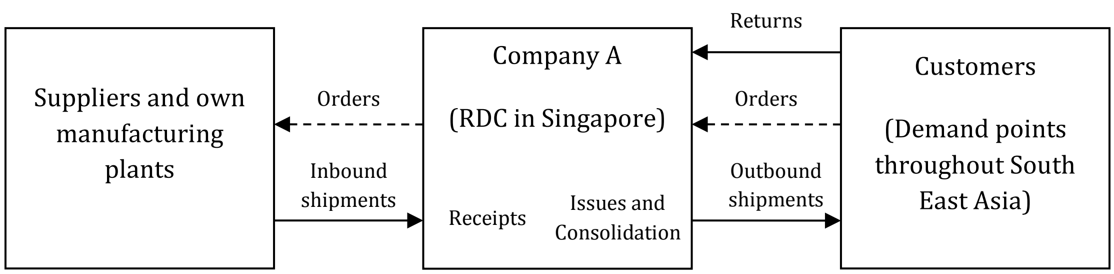

Figure 4.1: Typical Product and Order Flows at Company A

In this study, "order lead time" is defined as the time between the receipt of an order and the dispatch of products (and thus excludes the time that products spend in transit, which is highly carrier-dependent).

Company A had historically struggled to reduce order lead time to customers. This could be attributable to the large range of products and brands carried, coupled with demand that was highly sporadic (e.g. once-off orders for large construction projects). Even for mature products that had been on the market for more than 3 years, average historical order lead time was over 2 weeks and could be as long as three months. For more recently introduced SKUs (with less historical demand data), an order lead time of 3 weeks was typical.

The availability of new products is one of the key determinants of the successful conversion of customer awareness to trial (Robertson, 1993), particularly in its first 2 months of introduction. Thus, in 2012, Company A decided to introduce S&OP on a limited basis for a set of new closely-related SKUs. Order lead time data was available for 3 groups of products: 1) mature SKUs for which S&OP was *not* implemented; 2) immature SKUs that were introduced less than 2 years ago and for which S&OP was *not* implemented; and 3) new SKUs for which S&OP was implemented.

Figure 4.2 shows the order quantity versus order lead time information for a typical family of SKUs in the past 3 years, aggregated monthly. Even for such highly mature SKUs, order lead times tended to spike whenever demand rose (e.g. in months 21 and 31). The monthly standard deviation of orders was 125 units, while the mean was 274 units per month. The average order lead time over the past three years was 15.6 days (order lead times for individual orders ranged from 0 to 79 days). There was also no seasonality pattern. Consequently, demand planning was highly challenging.

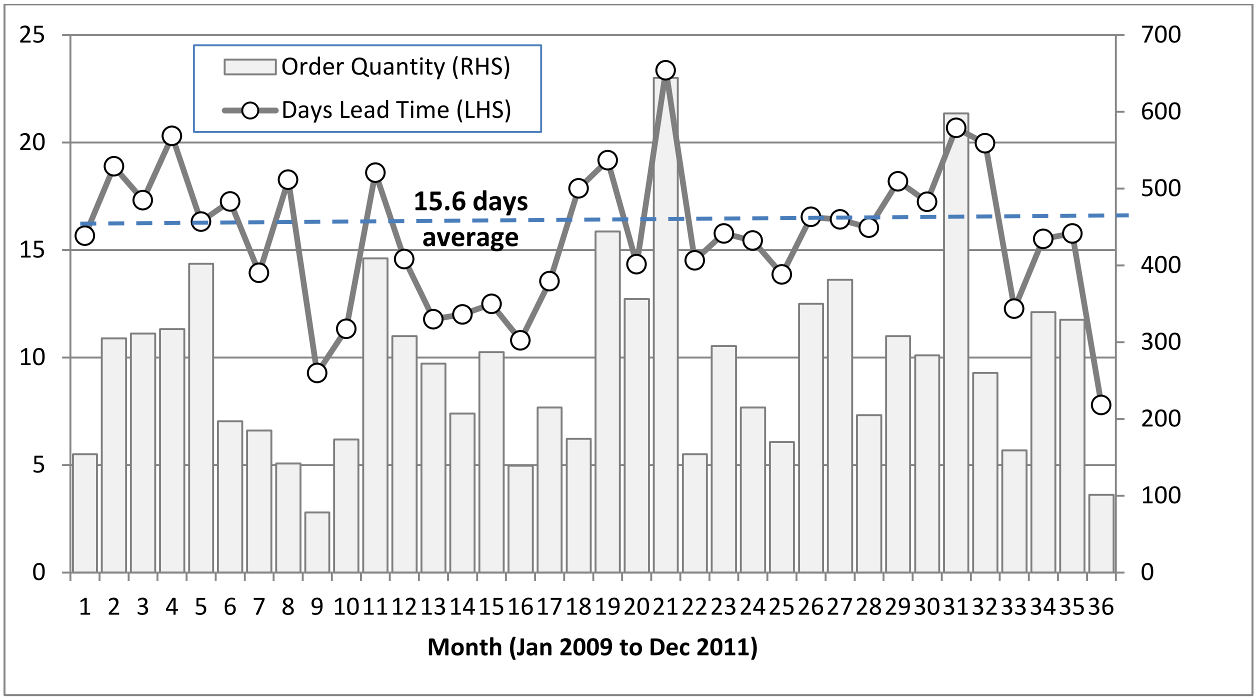

Figure 4.2: Order Quantities and Order Lead Times for a Mature SKU (S&OP not Implemented)

For new SKUs (Figure 4.3), owing to a short history of demand data, the order lead time could be as high as 30 days during the initial ramp-up period before declining gradually as demand became more predictable. The limitation of time-series desktop-based forecasting became apparent when there was a large step-jump in demand (from month 13 onwards), resulting in an increase in order lead time and a backlog that took 5 months to clear. During a period of almost two years in which the SKU had been available, order lead time averaged 22.4 days (versus 23.8 days in the first 2 months).

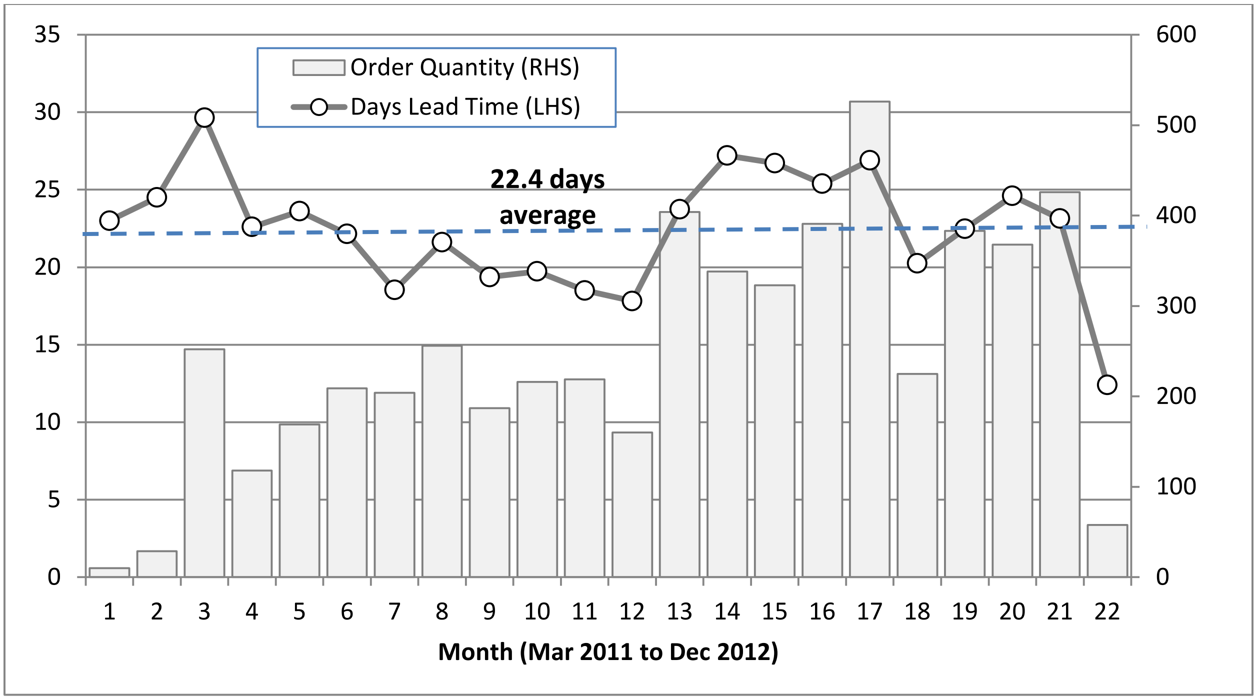

Figure 4.3: Order Quantities and Order Lead Times for a New SKU (S&OP not Implemented)

Faced with the above challenges, Company A rolled out S&OP for a set of new SKUs with the aim of reducing order lead times. Comparing the existing process (Figure 4.4a) and the new process (Figure 4.4b):

- Previously, the supervisor overseeing the production line for a specific SKU would review historical and expected consumption (demand), then recommend a production plan, upon which parts were procured to meet the plan. There was thus a distinct lack of a feedback loop between operations (in the manufacturing department) and the rest of the organization.
- In the new process, a weekly S&OP discussion takes place and involves stakeholders from sales, manufacturing, logistics and procurement, through which a consensus forecast is generated. This forecast is further reviewed to determine whether there is a need to adjust the parameters in the inventory policy for the given SKUs. If required, these changes are fed back into the MRP (Materials Requirement Plan) which is relied upon by the procurement department to place orders with suppliers.

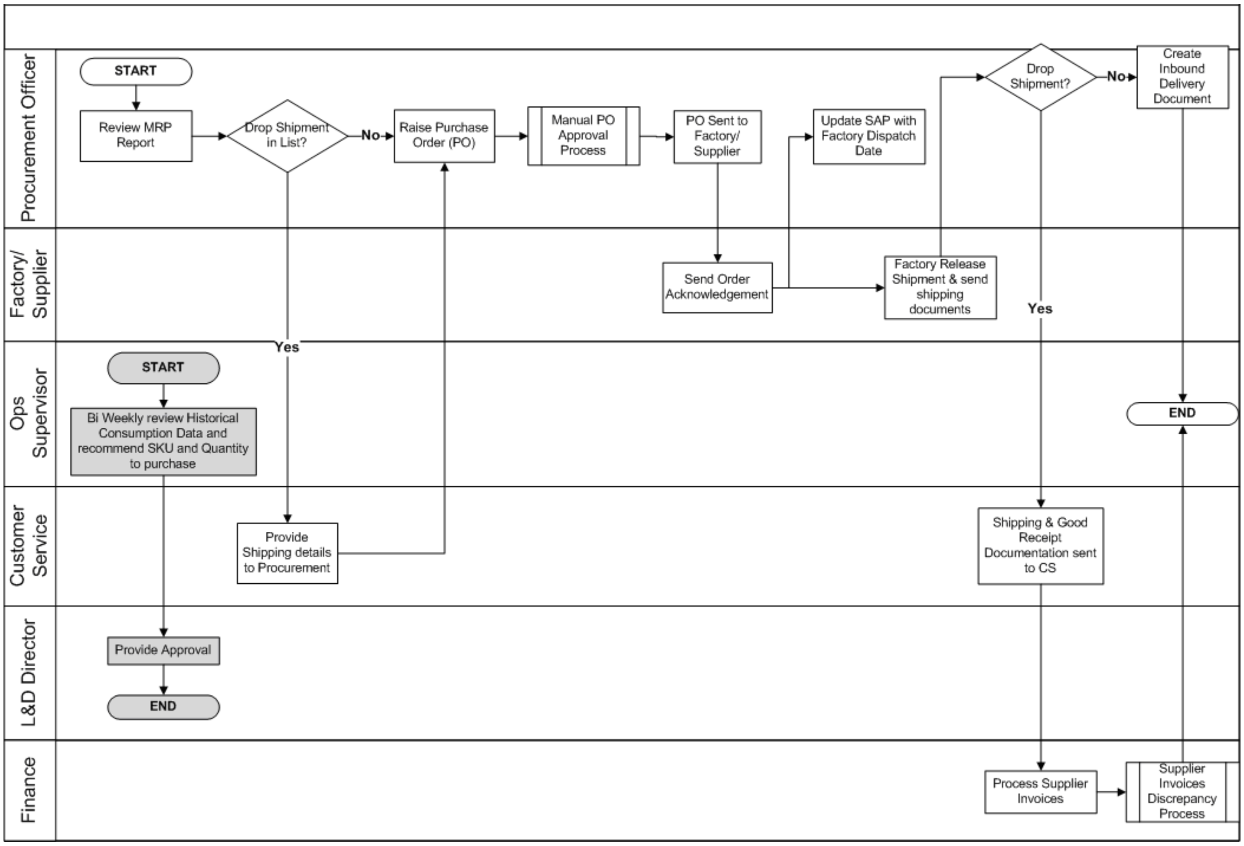

Figure 4.4a: Existing Process as Practiced by Company A

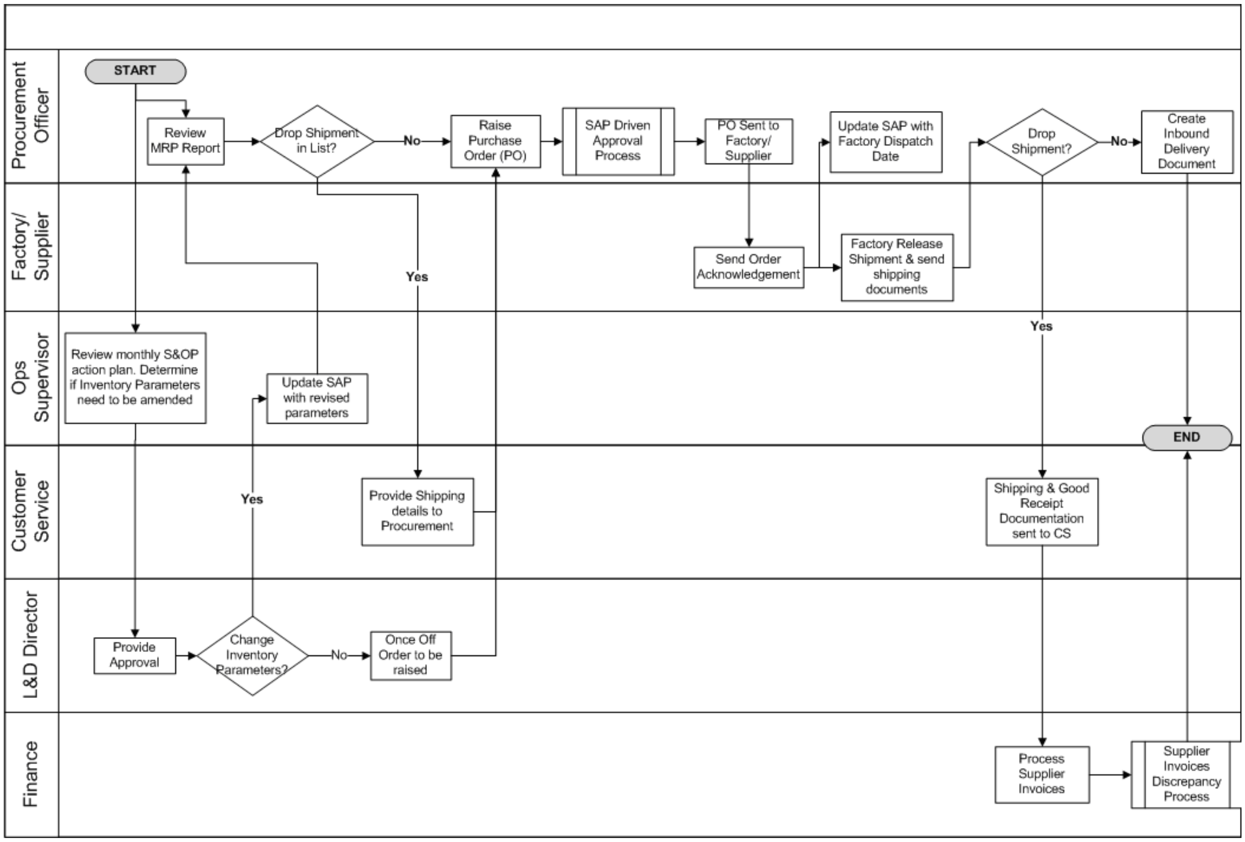

Figure 4.4b: New Process with S&OP as Practiced by Company A

As a direct consequence of the introduction of S&OP, there was a marked decrease in the average order lead time during the critical first 2 months of introduction for the set of new SKUs (Figure 4.5). The average order lead time was just 7.8 days, compared with 23.8 days in the corresponding period for the SKUs whose introduction was not facilitated with S&OP (Figure 4.3). This represents a 67% reduction in order lead time during NPI. Order lead time variability during NPI (as measured by standard deviation) was also reduced from 11.6 days to 4.3 days.

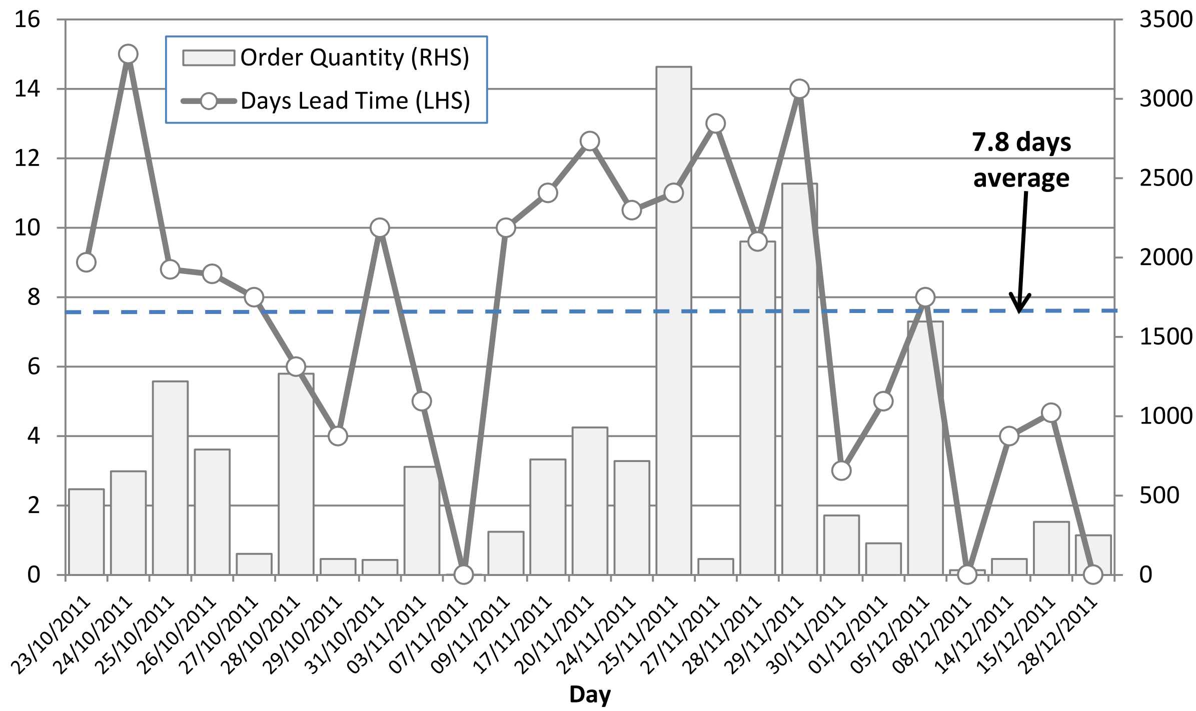

Figure 4.5: Order Quantity and Order Lead Times for a New SKU (S&OP Implemented)

While the S&OP implementation as described in the case above was internally-focused, the use of the process to aid in NPI differentiated it from other "standard" Stage 3 S&OP implementations.

4.2. Case 2 - S&OP with Supplier Integration

In 2010, Company B adopted a basic form of S&OP within its organization. Two years later, it further introduced a more mature version of S&OP that integrated a key supplier into its production process. Unlike Company A, Company B was less concerned with order lead times, since data center equipment are often mission critical and thus demand was generally fulfilled from stock. Rather, the supply chain was focused on maintaining a low level of inventory and a high level of forecast accuracy while ensuring a high fill rate.

Company B's "traditional" planning process started when forecasts from its customers were received during the first week of each month. Both the Sales and Operations departments would use these forecasts to formulate a master schedule against historical sales trend. The finalized master schedule would be uploaded into the SAP ERP system, whereby a supply chain forecast known as the Contract Manufacturing Shipment Schedule (CMSS) would be generated and provided to the contract manufacturer (CM). The CM would then review the CMSS and existing open purchase orders (PO) and commit on the actual deliveries according to the CMSS/PO requirement. There was thus an absence of feedback or a joint forecasting process between Company B and its contract manufacturer.

Figure 4.6 shows the key parties along the supply chain for a typical product carried by Company B. The product was manufactured by a contract manufacturer and delivered to Company B's regional distribution center (RDC).

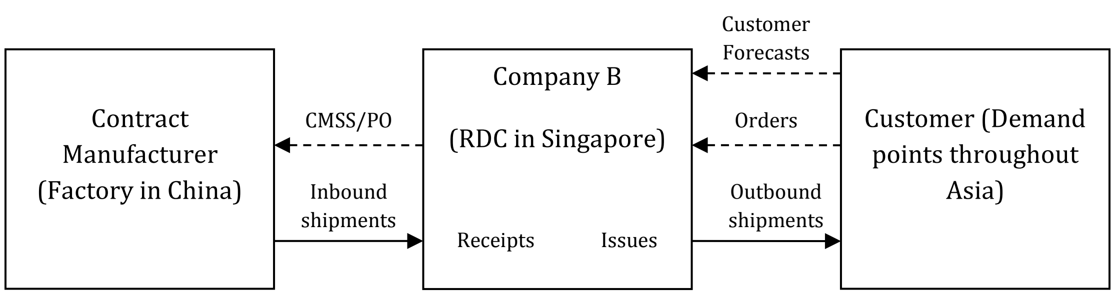

Figure 4.6: Simplified Supply Chain for a Typical Company B OEM Product

Two years after implementing Stage 3 S&OP, Company B had managed to meet customer demand with a lower level of inventory and achieved a higher level of customer satisfaction for their branded business. Inter-department collaboration had also improved as all stakeholders were geared towards common goals.

Despite the success of the S&OP process, buyers still found it necessary to constantly monitor inventory levels against actual demand and often made changes to the PO via pull/push outs or changes in product models. These corrective actions caused bull whip effects in the supply chain and strained the relationships with suppliers, especially towards the end of financial periods.

With its past success in S&OP implementation, Company B embarked on a new mode of collaboration with a key supplier in China. The collaboration required both Company B and the contract manufacturer (CM) to work together as a virtually-integrated team in an Advanced S&OP model, similar to the Stage 4 model under Grimson and Pyke (2007)'s framework.

Information (such as forecasts from the customer, reorder points and master production schedules) was shared by Company B with its contract manufacturing partner (who in turn analyzed its own supply chain for constraints). Based on the feedback from the contract manufacturing partner, Company B determined the level of expedites, rebalancing and adjustments needed to fulfill its customers' demand.

Figure 4.7 shows the 5 main stages of Company B's new process with its contract manufacturer.

Stage 1: Sales Forecasting	• Customer forecast is collected by Company B and distributed to CM for joint analysis against past trends and budgets.
Stage 2: Demand Planning	• Forecasted production quantity is determined by validating inventory level, and checked for any variation of forecast that needs adjustment. • Reorder Point (ROP) levels are computed based on customer historical trend or forecast average over the next 10 weeks. This ROP also takes into consideration production lead-time of 5 days with the default transportation mode transit-time (which depends on the customer's location). • The Master Production Schedule (MPS) is presented in weekly buckets and is adjusted according to customer pull trends. For example, certain customers have a tendency to pull up to 50% of their monthly demand during the last week of the month.
Stage 3: Supply Planning	• Based on the required MPS quantity, the CM determines whether there are any supply, material or capacity constraints in meeting the required demand. This information is presented in the weekly committed MPS to Company B.
Stage 4: Reconciliation	• CM will report if there is any expediting cost expected. Otherwise alternative plans such as site balancing or product priority adjustment will be considered.
Stage 5: Finalize S&OP Plan and Execute	• Once consensus is reached by both parties, a master production schedule will be produced by the CM and loaded into their production planning system. Company B will then issue a "Blanket PO" that provides production coverage for up to 4 weeks. • From this point onwards, the team starts to monitor inventory levels against ROP levels. When the ROP is breached, CM initiates production based on pre-agreed quantities and schedules to ship products to the respective hubs.

Figure 4.7: Company B's New S&OP Process with its Contract Manufacturer

During the planning stage the following information was shared between both parties.

1. Customer raw forecast
2. Warehouse inventory and safety stock levels
3. Historical shipments to end customers
4. Reorder Point (ROP) calculations based on statistical analysis
5. Master Production Schedule (MPS)
6. Raw material constraints
7. Production capacity constraints

During the execution stage, daily communications were conducted between operations, buyers and the CM planners. These sessions helped to reconcile any outstanding issues such as sudden increases in demand/forecast or changes in inventory due to abnormal transactions such as returns.

As shown in Figure 4.8, a key feature in the new Advanced S&OP process was that the Contract Manufacturer had direct access to the sales forecast provided by Company B's customer.

Production was triggered by a Reorder Point (ROP) that was jointly established with Company B, who issued a "blanket PO" upfront (instead of having to review each PO as was the case before).

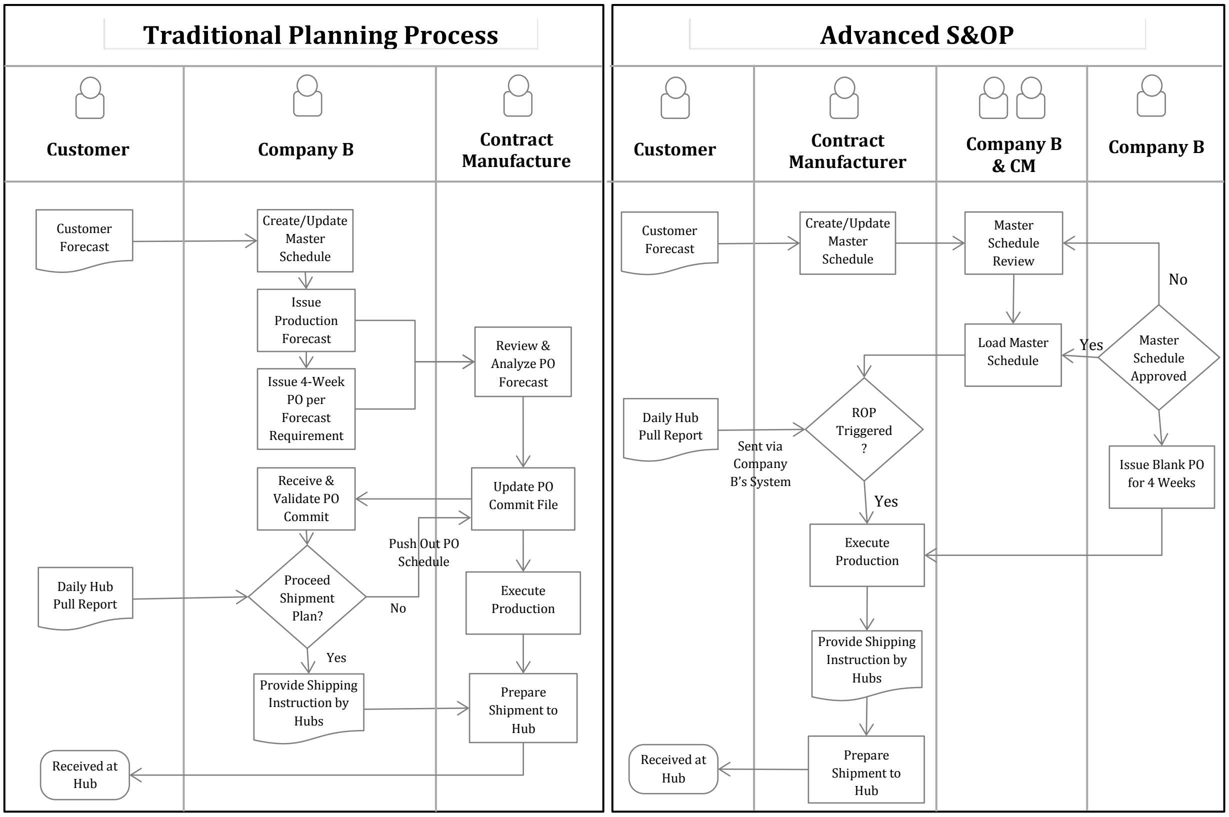

Figure 4.8: Flowcharts for Traditional Planning versus Advanced S&OP

Table 4.1 highlights other key differences between the 2 processes, in terms of the planning cycle, purchase orders, delivery triggers and changes in demand or supply.

Table 4.1: Traditional Planning versus Advanced S&OP

	Traditional Method	Advanced S&OP
Planning Cycle/ MPS/ CMSS Report	• Company B plans its MPS and uploads it into SAP system. • SAP calculates required orders based on current inventory, open POs, demand and part master setting such as transit lead-time to generate a CMSS report. • Buyers review and adjust the CMMS report before forwarding the forecast plan to CM to plan for its own MPS. • MPS is reviewed every month, while CMSS is reviewed every two weeks. • Errors may occur in CMSS report when the part master settings such as transit lead-time are set wrongly in Company B's SAP.	• Company B and CM share the same agreed MPS for each part number in a common planning platform and load the MPS into its system at the same time. • Both Company B and CM conduct joint MPS reviews every two weeks. • During mid-month review, weekly MPS and MPS Commit are changed to match customer demand.
Purchase Orders (PO)	• Each buyer places multiple purchase orders within a defined approval limit (average 30~50 POs for each buyer).	• Buyers place the reviewed parts and quantity into a single Master Scheduling Agreement (MSA or also known as Blanket PO) for management approval.
Trigger Point for Delivery	• Safety stock level breached • PO scheduled date due	• ROP level triggered
PO Management (Customer changes in demand/ suppliers changes in commit)	• SAP system recommends suitable actions for each PO/ Purchase requisition (PR) line after MRP run. • Buyers review the system data and check with CM on adjustment for the PO dates in order to maintain the desired inventory level.	• System auto-generates purchase requisition (PR) based on MSA. • System calculates the necessary changes and adjusts the dates on PR lines. • Buyers will convert the PR into single PO for delivery when ROP is triggered.

Prior to a roll-out on a larger scale, a four-month pilot study was conducted on the SKUs demanded by a major customer of Company B. The fulfillment of this customer's demand before and after the implementation of the Advanced S&OP process was investigated, in particular

- the inventory per unit sales used to meet demand and
- forecast accuracy, which can be indirectly measured by the weekly imbalance between inbound and outbound shipments at its regional distribution center in Singapore.

Data for 45 weeks before and 19 weeks after the commencement of the new process was made available for analysis. During this period, there were no external events (e.g. major natural disasters) or other internal activities such as the large scale introduction of new products that could have contributed to major shocks in the supply chain. Such factors would be more difficult to control over a prolonged study period.

4.2.1. Inventory Level

Higher sales generally require higher levels of inventories. Hence, in this analysis, the level of inventory normalized against demand was computed, such that:

$$\textit{Normalized Weekly Inventory} = \textit{Average Weekly Inventory} / \textit{Average Past 4 Weeks of Sales} \quad (1)$$

A low level of normalized inventory typically indicates superior performance in inventory control. The chart below is the plot of an index of normalized inventory, before and after the Advanced S&OP process was introduced.

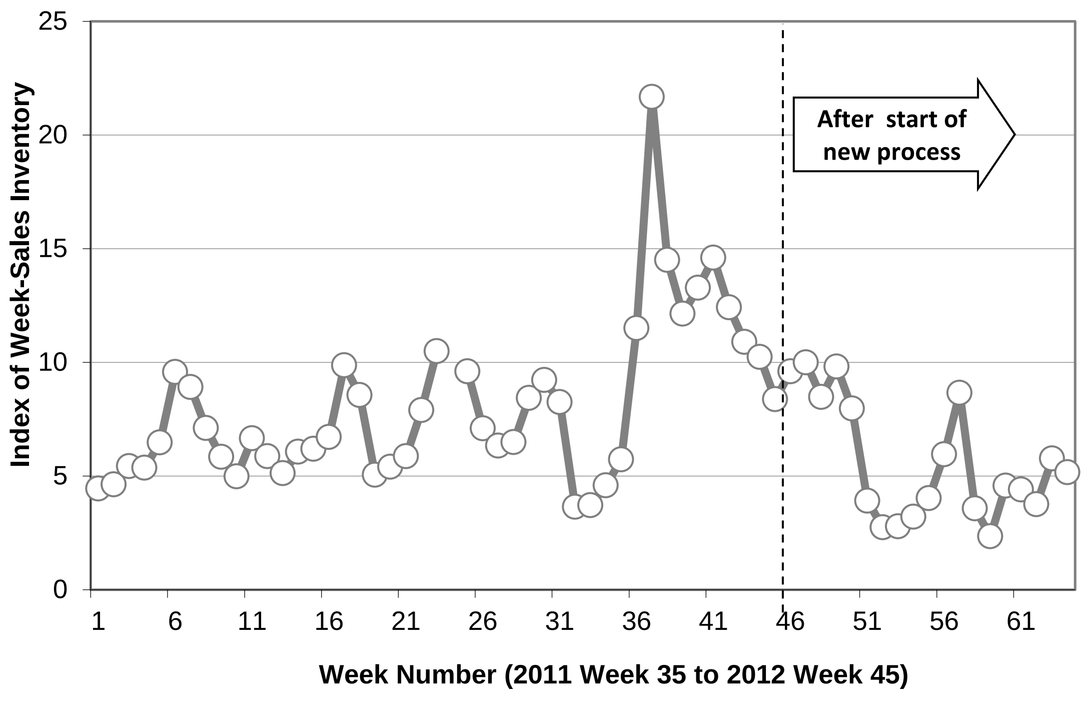

Figure 4.9: Normalized Inventory Before and After Advanced S&OP

(Note: The normalized inventory level for Week 24 (with a high value of 50) was identified as an outliner and removed from the data set during analysis. This outliner was the result of extremely low sales in January 2012 which corresponded to the Lunar New Year period, even though average inventory level had remained relatively stable.)

The results of the analysis showed that there was a 30.4% reduction in inventory levels in the weeks after the new process was introduced. However, due to the limited scale of the pilot study and the large fluctuations in inventories (which is a characteristic of the high-tech industry), a *t-test* was conducted to ascertain the significance of the impact of the Advanced S&OP process, which showed that inventory was significantly reduced (with p=1.75%).

4.2.2. Forecast Accuracy

Past forecasts were not available for this study so a surrogate analysis was conducted by comparing weekly inbound versus outbound shipments at the regional distribution center (RDC). A positive imbalance (i.e. receipts greater than issues) over a short period indicated that the inventory at the RDC was rising, most probably as a result of forecasted demand being greater than actual demand. Similarly, a negative imbalance (i.e. receipts less than issues) over a short period indicated that the inventory at the RDC was reducing, most probably as a result of forecasted demand being less than actual demand. This was a more rigorous test than analyzing inventory levels, as it also took into account under-forecasting. Under-forecasting results in overly-low inventories that may appear desirable but are not sustainable. It can also greatly increase the likelihood of stock-outs.

As receipts were usually put into stock at the RDC for an average of about a week before they were shipped out, an offset of 1 week was applied to outbound data when computing imbalance. To account for delays in ocean shipping (which may for example cause scheduled receipts to arrive in the following week), the receipts and issues values were smoothed over two weeks. Therefore, imbalance was computed as follows:

$$\begin{aligned} \textit{Imbalance} &= \textit{Average of receipts (week x and week x+1)} \\ &\quad - \textit{Average of issues (week x+1 and week x+2)} \end{aligned} \tag{2}$$

Since the objective was to investigate overall forecast accuracy rather than over-forecasting or under-forecasting specifically, the *absolute* imbalance between receipts and issues was calculated and plotted in Figure 4.10, for the period before and after the Advanced S&OP process was introduced.

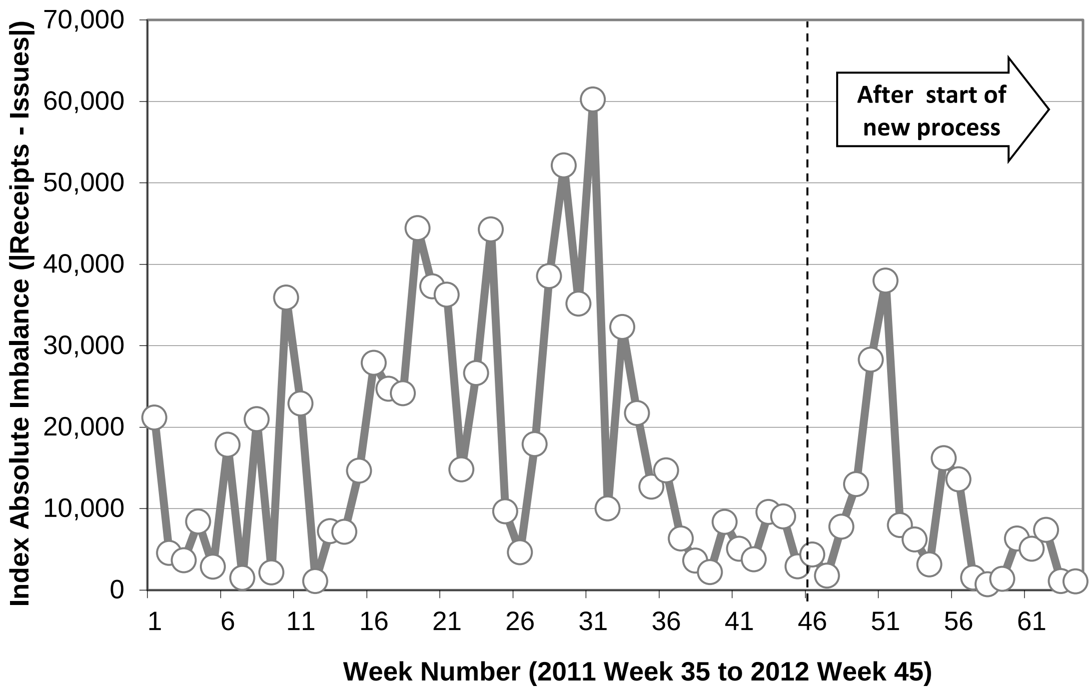

Figure 4.10: Balance between Inbound and Outbound Shipments

Results from the analysis show that the absolute imbalance of 8,637 (index) after the adoption of Advanced S&OP process is a 52.1% reduction from the 18,035 (index) before.

From Figure 4.10, it is apparent that prior to introducing the new process, there was a tendency for the absolute imbalance between receipts and issues at the RDC to fluctuate dramatically from week to week, possibly as a result of the buyers' efforts to compensate for over and under-forecasts in past periods. This effect was noticeably under control during the pilot study.

A t-test was again conducted to determine whether the mean absolute imbalance between receipts and issues after the introduction of the Advanced S&OP process was significantly lower than that before. Seasonal effects were assumed negligible in the absolute imbalance time series since seasonality (if present) would have been accounted for during demand forecasting. The t-test result showed that the introduction of the Advanced S&OP process had very significantly reduced (p=0.25%) the imbalance between inbound shipments from the contract manufacturer and outbound shipments to the customer. Since there were no external special causes during the period of data collection, this improvement was most probably attributable to improved forecast accuracy with the implementation of the Advanced S&OP process.

5. Discussion of Findings

As summarized in Tables 5.1a and 5.2b, the findings from the two cases show that S&OP has helped Company A and Company B achieve significant improvements in their supply chains.

Table 5.1a: Summary of Performance Improvements in Case 1 - Internal S&OP as Applied to NPI

Supply chain metric	Case 1: Internal S&OP as Applied to NPI			
	Before	**After**	**% Reduction**	**Significance of improvement**
Order lead time (days)	23.8	7.8	67.2%	$p<0.1\%$
Order lead time standard deviation (days)	11.6	4.3	62.9%	$p<0.1\%$

Table 5.1b: Summary of Performance Improvements in Case 2 - S&OP with Supplier Integration

Supply chain metric	Case 2: S&OP with Supplier Integration			
	Before	**After**	**% Reduction**	**Significance of improvement**
Inventory level (index)	8.06	5.61	30.4%	$p=1.75\%$
Forecast accuracy as measured by shipment imbalance (index)	18,035	8,637	52.1%	$p=0.25\%$

These findings are hardly surprising, given that there have been many authors in the literature who have reported positive outcomes from S&OP (Cacere et al., 2009). It should however be noted that successes from S&OP are not a given. Some companies have implemented S&OP but not achieved the expected results (Wagner, 2014). Some of the key factors that have contributed to the success in the two cases were strong management support and structured S&OP processes with the active participation of internal stakeholders (and also in the case of Company B, its supplier). These factors were also present as enablers in previous S&OP implementations as reported in literature (Grimson and Pyke, 2007; Milliken, 2008; Iyengar and Gupta, 2013).

Moreover, both cases involved a well-defined and targeted subset of SKUs, rather than the entire collection of active SKUs. These reduced the potential complexity of the S&OP programs and ensured that the processes remained manageable. Segmenting SKUs (rather than focusing on all SKUs) based on those that contribute most to sales or have the most volatile demand is also an approach advocated by Iyengar and Gupta (2013).

5.1. S&OP Maturity Assessment

A maturity framework can be useful for practitioners to gauge a given company's ability to execute S&OP to achieve certain targets, by assessing that company's maturity against those of other companies that have been though the same S&OP journey.

Figure 5.1 summarizes the relative maturity of S&OP at Company A and Company B, according to the framework proposed by Grimson and Pyke (2007). Besides making objective judgments based on the S&OP processes as described earlier, the assessment is also based on interactions with employees at the companies featured in the case studies.

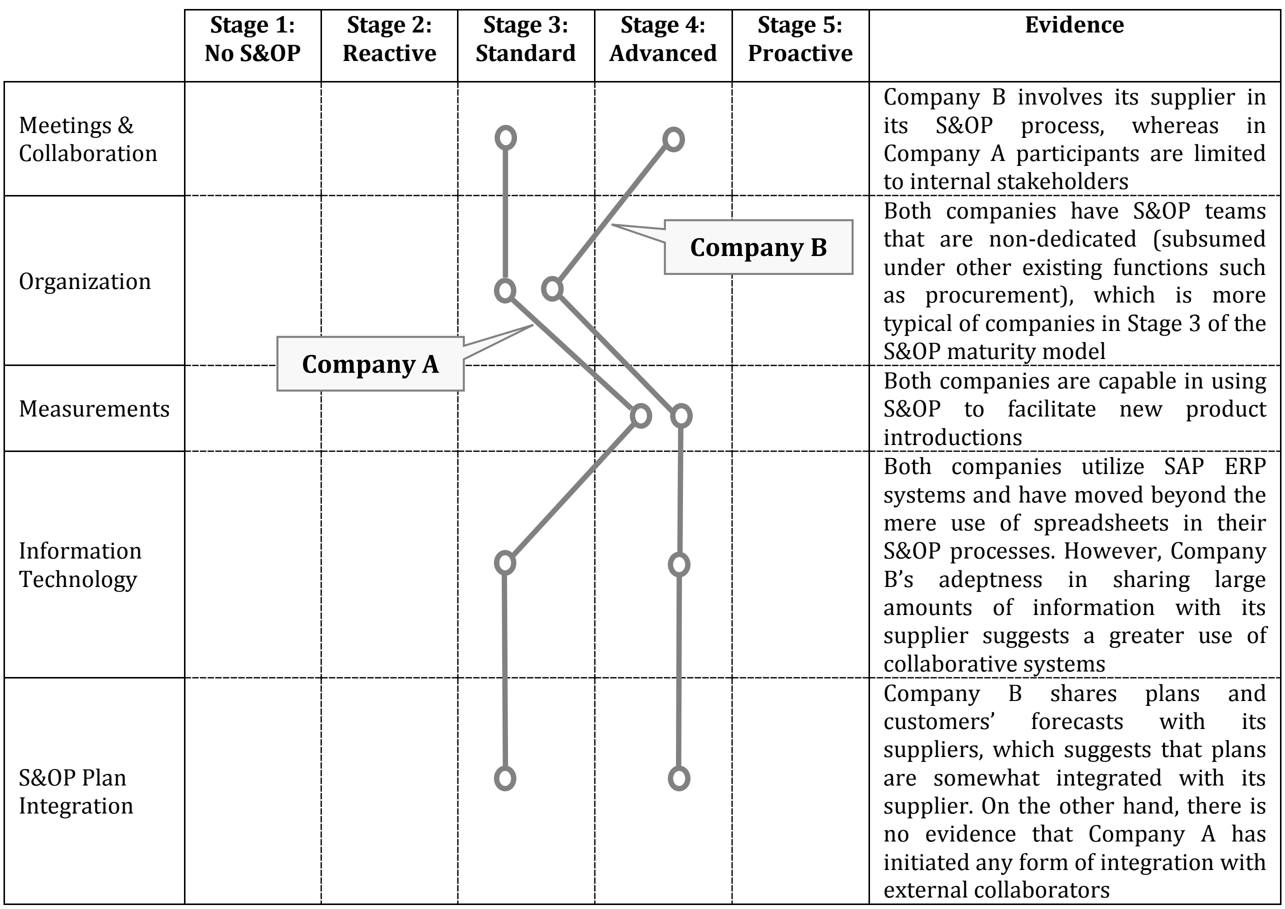

Figure 5.1: S&OP Maturity Assessment of the Two Companies in the Case Studies

Company A is almost a typical company that practices Stage 3 “Standard S&OP” (except that it uses S&OP for NPI which is less common for a Stage 3 implementation). It has achieved significant improvements in order lead time (as well as reduced variability in order lead times). The implications for Company A are two-fold. First, the findings have provide very strong support that it has been successful in implementing S&OP and provided a means for the company to justify its investment in time and effort on the new process. Secondly, as the S&OP process becomes more established, the company should investigate areas for further performance gains, by evolving to the next stage of S&OP.

On the other hand, Company B is leaning towards a Stage 4 “Advanced S&OP”, but as there is no dedicated S&OP team, the “organization” dimension falls just short of Stage 4 maturity according to Grimson and Pyke (2007)’s framework. However, it is worth noting that other maturity frameworks (Lapide, 2005; Wagner et al., 2014) do not specifically address the need for formal teams to manage a mature S&OP process, as long as formal processes are in place. As such, Company B’s implementation is essentially Stage 4. Consequently, it would not be imperative for Company B to attain Stage 4 maturity in the “organization” dimension, before it moves to Stage 5. Company B had integrated a supplier for a small sub-set of its SKUs, so a next logical step would also be to investigate the possibility of expanding the new process to more SKUs and suppliers.

Furthermore, both companies took a step-change approach towards S&OP. For instance, Company B had implemented “Standard S&OP” for two years and allowed for its processes to stabilize before making the next major step towards “Advanced S&OP”. As Lapide (2005) noted, moving more than one stage in an S&OP maturity model is over-ambitious and will likely lead to failure.

The results from the two cases thus lend support to the propositions that there are significant benefits from implementing a Stage 3 S&OP (Case 1) and that there are potential incremental gains from transitioning from Stage 3 to Stage 4 S&OP (Case 2).

5.2. Implications for Asia Pacific Companies

The findings of the study have important implications for companies in the Asia Pacific region. Firstly, there does not appear to be any evidence that suggests S&OP would be less effective in other Asian manufacturing companies, despite the lack of relevant past case studies from this region. By setting organizational objectives that are aligned and by gradually “leveling up” along the S&OP maturity curve, companies in Asia Pacific can potentially achieve significant improvements to their supply chain performance. However, one implication of the maturity assessment matrix, for example, is that a company that is assessed to be in Stage 3 (or lower) of the maturity model is unlikely to be able to immediately achieve supply chain improvements to the extent that Company B had.

While the two companies selected for the cases in this paper are both manufacturing companies, they share little commonality in terms of product characteristics, demand profiles and supply chain priorities. Yet, each had been able to apply S&OP in ways that met its own objectives and achieve measurable improvements in supply chain performance. This lends support to the observation that S&OP can be adapted to meet a wide of requirements, particularly in Asia Pacific countries where market maturity, logistics infrastructure and supply chain challenges are very diverse. The term “Standard S&OP” (to represent Stage 3 of S&OP) may also be misleading, since no two companies are likely to face the same operating conditions and challenges and there is unlikely to be a standardized template that can be applied across various companies and industries.

Finally, the literature has suggested that the most successful manufacturers seem to be those that have carefully linked their internal processes to external suppliers and customers (Zailani and Rajagopal, 2005). By narrowly focusing just on internal collaborations (as results from the exploratory survey in Figure 3.1 suggest of current implementations), companies in Asia Pacific could risk overlooking the potential benefits from external integration, beyond what could be achieved from a basic form of S&OP.

5.3. Research Limitations

The methods as presented in this paper are not without their limitations. For one, this paper describes the outcomes from studies at just two companies. It must be emphasized that these are certainly not intended to be representative of outcomes at all companies implementing S&OP. Due to the dynamic nature of the industries studied, the results are also based on a limited snapshot of performance pre- and post-implementation of the respective forms of S&OP. In addition, the results as described are also specific to a specially targeted set of SKUs and the performance improvements may not be representative of other SKUs with different characteristics. It is also unclear how well the results would scale when the methods presented in the case studies are extended to smaller organizations that do not necessarily have the same amount of resources that can be devoted to S&OP. Moreover, the ability to implement Stage 4 “Advanced S&OP” as described in Case 2 would depend on the amount of influence that an organization can wield over its suppliers, which implies that such a mature S&OP model may only be applicable to companies above a certain scale of operations. The application of S&OP at a broader sample of Asia Pacific manufacturers is therefore worthy of further study in the future.

6. Conclusion

The purpose of this paper is not to assert that S&OP works generally, on the basis of results from two case studies. Rather, it is to explain and describe the unique experiences and quantitative outcomes of implementing innovative variants of S&OP at two companies that are at different stages of their S&OP journeys. If anything, the two case studies have reinforced the fact that S&OP

should not be viewed as a standardized tool but rather should be tailored towards the specific objectives of organizations, be it reducing lead times or reducing inventories.

The results of the study strongly suggest that S&OP has helped reduce order lead time by 67% for a new product introduction (NPI) at the first company. By involving its key supplier in an advanced form of S&OP, the second company significantly improved both its inventory level and forecast accuracy by 30% and 52% respectively. Ultimately, these can translate into better financial outcomes for the organization and/or higher levels of customer satisfaction.

This paper contributes to the literature in several ways. Firstly, it has added to the growing body of academic research on S&OP, for which there is still a lack of well-documented case studies describing S&OP process in different cultures and industries (Thomé et al., 2012). As Tuomikangas and Kaipia (2014) pointed out, academic authors have emphasized the need for empirical research to complement existing modeling and simulation studies. The case studies that have been reported in this paper illustrate not just the benefits from two different applications of S&OP (in facilitating new product introductions as well as in supply chain integration), but also describe how the target companies achieved those performance gains.

Secondly, this paper has helped bridge the gap between practitioner and academic discourse in the subject of S&OP. Articles in practitioner journals are generally concerned with the execution and qualitative aspects of implementing S&OP (e.g. success factors and process improvement). On the other hand, academic researchers in S&OP tend to focus on framework development and evidence-based models (e.g. correlations between collaboration versus performance). This paper has reviewed a balanced mix of literature from academic and practitioner journals and provided direct quantitative evidence of the possible supply chain performance improvements from S&OP, based on actual data from the industry. This paper is the one of the few (if not the first) to have described the S&OP process of a firm (Company B) that has met the criteria of a Stage 4 S&OP implementation. This paper has also provided evidence of the potential incremental performance gains from transitioning between Stage 3 and Stage 4 S&OP, which supports Thomé et al. (2014)'s survey-based finding that supplier integration amplifies the impact of internal S&OP.

Thirdly, the paper has contributed a set of findings on the success of S&OP in the Asia Pacific region, where research (whether practice-based or academic-based) on S&OP has been scarce. Considering that Asia accounts for nearly 40% of the world's manufacturing output, the role that S&OP could play in Asian manufacturing is still very much unexplored. The two cases presented could thus help bring greater attention to S&OP among manufacturers in the Asia Pacific region.

Several further avenues of research can be identified as a result of the findings of this study. One such avenue is the role that S&OP can play within the umbrella of supply chain collaborations. Company B and its supplier's joint initiative can be viewed as an excellent example of external (or virtual) integration where supply chains are composed of independently managed but tightly linked companies (Erhun and Keskinocak, 2011). For such collaboration to work, it should be mutually beneficial. By analyzing how a supplier would also benefit from being involved in a customer's S&OP process, a stronger case could be made for the significance of performance improvement along the entire supply chain. Secondly, results from the limited number of responses gathered during the preliminary survey in this research have suggested that firms have faced various impediments in their implementation of S&OP. Such barriers to implementing S&OP are worthy of further research from an academic perspective. Thirdly, the case study method is by its nature unable to confirm (or otherwise disprove) whether the lack of examples of S&OP in Asia-Pacific can be attributed to regional/cultural factors (as suggested by Zailani and Rajagopal, 2005) or other reasons. There is thus scope to expand research in this area via results from a large scale international survey. Finally, it is likely that industry type, product type and a firm's characteristics (ownership, age, size etc.) could affect the degree to which the company could benefit from S&OP or other forms of supplier collaboration. Such a relationship, if it can be established, would be of great interest to academics and practitioners alike.

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