The Impact of Sales and Operations Planning on Supply Chain Performance: An Investigation of Contingency and Organisational Culture in S&OP Implementations

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Declaration

This thesis has not been submitted in support of an application for another degree at this or any other university. It is the result of my own work and includes nothing that is the outcome of work done in collaboration except where specifically indicated. Many of the ideas in this thesis were the product of discussion with my supervisor Dr Stephen Eldridge.

Excerpts of this thesis, corresponding to the three papers in Chapters 4 to 6, have been published in the following academic publication and conferences.

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Paper 2 (in Chapter 5) is in third-stage review following submission to a journal and Paper 3 (in Chapter 6) is ready for submission.

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Abstract

S&OP is a 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 of resources and most profitable supply chain mix. S&OP can also be described as a means for internal coordination in which a cross-functional team reaches consensus on sales forecasts, capacity and/or production plans. This thesis aims to develop a deeper understanding of S&OP and in turn the specific means through which supply chain performance is impacted, via a combination of the case study and survey methods. The results from the first phase of this study show that in the case studies of the two separate companies, both cases show significant quantifiable improvements in supply chain performance from implementing S&OP. In the second phase of this study, a large-scale survey was conducted to test the efficacy of six coordination mechanisms of S&OP and the effect of contingency factors. Results based on 568 respondents indicate that Strategic Alignment and Information Acquisition/Processing are the mechanisms that most significantly enable superior S&OP outcomes. However, the survey dataset strongly suggests that a highly formalised S&OP Procedure inhibits supply chain performance. Furthermore, from a contingency theory perspective, increasing firm size and increasing experience in S&OP amplify the negative effect of a standardised S&OP Procedure upon supply chain performance. In the final phase of this study, the effect of organisational culture as an antecedent to S&OP coordination mechanisms is explored. Results show that a strong S&OP culture leads to better overall coordination outcomes, but a strong S&OP culture may concurrently suppress Supply Chain Performance via the S&OP Procedure/Schedule pathway due to competitive mediation.

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Chapter 1 – Introduction

1.1. Relevance and Justification of the Research

Supply chain management is a discipline that has evolved in the past few decades to help firm achieve the aim of supplying goods and services to fulfil customers' needs. As a management philosophy, supply chain management is based on a unified systems approach towards the supply chain, has a strategic orientation toward cooperative efforts to synchronise intra-firm and inter-firm capabilities and has a focus on customer satisfaction (Ross, 1997; Mentzer et al., 2001). Similarly, the Council of Supply Chain Management Professionals defines supply chain management as encompassing the planning and management of all activities from sourcing to logistics, integrating supply and demand management within and across companies and driving coordination of processes and activities with and across marketing, sales, product design, finance, and information technology (Council of Supply Chain Management Professionals, 2013). Strong supply chains are also often seen a key aspect of a firm's competitive advantage (Mentzer et al., 2001, Li et al., 2006).

However, as scale of production grows and complexity increases, coordinating within and across the supply chain becomes more difficult. Some challenges in the supply chain are internal, while others are external. Examples of external challenges are exogenous environment settings, such as demand/supply uncertainty, competitive pressures on cost/service, extended supply chains and more suppliers/customers. On the other hand, internal challenges include issues related to multiple-functions, cross-disciplinary teams, a complex organisation and an increasingly varied product range. A functional divide can also exist within most organisations, which is often embedded with a company's organisational structure and culture (Fawcett and Magnan, 2002). In

particular, organisational units operating in differing environments develop different internal unit characteristics, and that the greater the internal differences, the greater the need for coordination between units (Lawrence and Lorsch, 1967a). When a firm is small, a strong authoritative leader/founder can act as an "entrepreneur-coordinator" (Coase, 1937), but as firms grow, the natural limits of such a system eventually become apparent. Hence, supply chain management is commonly associated with constructs such as communications, cross-functional teams, supplier involvement and logistics integration (Chen and Paulraj, 2004).

Firms also often face a dilemma on the trade-off between an exploitative versus explorative approach (or an efficient process versus a creative process) in formulating a supply chain strategy (Kristal et al, 2010). One view is that an "S-curve", in which as a product/firm matures, it switches from creativity/growth to efficiency/stability (e.g. Porter, 1980). However, the transition is not always so distinct, as organisations recognise that they need to have both to sustain a competitive advantage. Besides, product lifecycles are becoming shorter and hence firms must go through multiple rounds of exploration-exploitation at an increasingly rapid pace. The challenge for supply chains is thus exacerbated by how multiple components in the organisation can be coordinated to meet the requirements of the modern market place.

Sales and Operations Planning (S&OP), a form of organisation and supply chain coordination, is a generic tool that has shown promise in addressing the above challenges and is popular in the industry (Wallace, 2013; Noroozi and Wikner, 2017). S&OP is a 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 of resources and most profitable supply chain mix (Muzumdar and Fontanella, 2006). S&OP can also be described as a means for internal coordination in

which a cross-functional team reaches consensus on sales forecasts, capacity and/or production plans (Lapide, 2004a). The APICS Dictionary (15th edition) formally defines Sales and Operations Planning (S&OP) as "a process to develop tactical plans that provide management the ability to strategically direct its businesses to achieve competitive advantage on a continuous basis by *integrating* customer-focused marketing plans for new and existing products with the management of the supply chain. The process brings together all the plans for the business (sales, marketing, development, manufacturing, sourcing, and financial) into one integrated set of plans." (Pittman and Atwater, 2016). Therefore, S&OP can be thought as a form of internal (or intra-organisational) integration in the supply chain. From an academic perspective, it is not just an operations management tool but also an organisation integration tool.

The reported benefits of S&OP are numerous and include: higher customer satisfaction; lower and more balanced inventory; lower lead times; more stable production rates; more cooperation across the entire operation; better forecasting; more efficient decision making; and a greater focus on the long-term horizon (Thomé et al., 2012a; Tuomikangas and Kaipia, 2014; Noroozi and Wikner, 2017).

1.2. Statement of the Problem

Although S&OP can be viewed as a specific type of coordination/collaboration, development of S&OP has been practitioner-led with little academic attention until recently. While academic interest in S&OP has increased, there have been relatively few case studies and evidence of the results of mature implementations (Qi and Ellinger, 2017), particularly in the process-based industries (Noroozi and Wikner, 2017). Moreover, the literature does not adequately explain how S&OP works, in relation to

organisational theory. For example, it is unclear whether S&OP evolved naturally in firms that "survived", or whether it is a formalised collection of tools and processes that can be acquired or cultivated. The fact that external consultants can help set up S&OP programmes (Cacere et al., 2009; Bower, 2011) suggests that S&OP is imitable. If so, how can other firms imitate best practices in S&OP? Are there any environmental variables or organisational cultural traits that preclude some firms from imitating and enjoying success? Do more "mature" S&OP programmes necessarily derive better benefits from S&OP than less mature programmes?

1.3. Purpose and Research Questions

The main purpose of this thesis is to study the efficacy and mechanisms of S&OP as an intra-organisational coordination tool from an academic lens and based on empirical evidence. Specifically, this thesis aims to:

- Present case study evidence of the effectiveness of S&OP.
- Test the strength of S&OP coordination mechanisms under a set of moderators via a large-scale survey of S&OP practitioners and thus recommend ways in which context-dependent S&OP programmes can be better designed.
- Investigate using organisational theory the extent that organisational culture acts as an antecedent in successful S&OP implementations.

The overarching research question is therefore how well the theories from operations management and organisation science can help explain and predict improvements in performance from implementing S&OP. Consequently, corresponding to each of the above-stated aims of this thesis, the following thesis questions (TQ) have been formulated:

TQ1 Is there empirical evidence that S&OP (as practised in the industry) contributes to improved supply chain performance and to what extent would S&OP maturity frameworks be adequate in linking S&OP maturity to improved supply chain performance?

TQ2 What are the relationships between the mechanisms of S&OP and the outcomes of S&OP implementations in a more generalised setting, and in what context would these individual mechanisms exert the greatest influence?

TQ3 How does an organisation's culture influence the effectiveness of coordination mechanisms and hence S&OP outcomes?

1.4. Thesis Structure

This thesis comprises three papers on the empirical study of the linkages between S&OP, its coordination mechanisms and supply chain performance outcomes.

Chapter 2 provides a broad overview of theoretical developments in organisational coordination, followed by an examination of coordination in the supply chain context and a review of the S&OP literature.

Chapter 3 provides an overview of the research design process and methodological perspectives, including justifications for the methods selected for this thesis, sequence of methods employed and the inductive-deductive-abductive balanced approach of the study.

Chapter 4 contains the paper titled "New Product Introduction and Supplier Integration in Sales and Operations Planning: Evidence from the Asia Pacific Region". This paper

investigates the implementation and performance benefits of Sales and Operations Planning (S&OP) via a case study of two companies within an S&OP maturity framework. 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 programme.

Chapter 5 contains the paper titled "Sales & Operations Planning: The Effect of Coordination Mechanisms on Supply Chain Performance". This paper investigates the effect of S&OP on supply chain performance using the perspective of coordination and contingency theories, via a large-scale global survey of experienced S&OP practitioners. A structural equation model was developed in which six S&OP coordination mechanisms were hypothesised to contribute to improved supply chain performance. The effects of contingency factors are also modelled through a series of moderation analyses.

Chapter 6 contains the paper titled "Sales & Operations Planning: The Mediating Effects Between S&OP Culture and Supply Chain Performance". This paper investigates mediation in Sales and Operations Planning (S&OP) and the role of Culture as an antecedent of superior S&OP outcomes. By viewing S&OP coordination mechanisms as an S&OP team's internal means of coping collectively with challenges to be resolved in a supply chain, five S&OP coordination mechanisms were hypothesised to act as mediators between "S&OP Culture" and Supply Chain Performance in a multiple mediator model.

Chapter 7 provides the overall conclusions for this thesis, implications of the results, limitations and some directions for future research.

Chapter 2 – Literature Review and Theoretical Foundations

Sales and Operations Planning is at its essence a means of internal coordination that occurs at the intersection of management science and organisation science, although the incorporation of the behavioural dynamics of key actors within organisations is less established in the operations management literature (Oliva and Watson, 2011). As such, this chapter first presents a review of the concept of organisational coordination generally, followed by the more specific topic of supply chain coordination. The theoretical background and some key research themes from the S&OP literature are then presented.

2.1. Organisational Coordination

Organisational coordination is often associated with many terms such as "cross-function teams", and "intra-organisational processes" in the literature (e.g. Pinto et al., 1993; Hauptman and Hirji, 1999; Tsai, 2002). It is also linked to terms such as "collaboration", "integration" and "cooperation", which do not necessarily have the same meanings. Coordination in an organisation may also exist at different levels. For instance, Bhatnagar et al. (1993) differentiate between "general coordination" (in terms of aligning decisions of different functions) and coordination that is within the same function at different echelons in the organisation (such as in a large vertically integrated firm). Therefore, given that S&OP is a means of organisational coordination, it is first necessary to define the concept of coordination in organisational theory.

2.1.1. Defining coordination

Numerous definitions of coordination exist in the literature, as summarised in Table 2-1. Lawrence and Lorsch (1967a) view coordination as the resolution of intra-organisational goal conflict, whereas Malone and Crowston (1994) state that coordination is about "managing dependencies between activities". Faraj and Xiao (2006) define coordination as a "temporally unfolding and contextualised process of input regulation and interaction articulation to realise a collective performance". It can be observed that the academic perspective of organisational coordination has evolved somewhat from a view of compromise to that of an action and performance-based relationship.

Table 2-1: Definitions of Organisational Coordination

Authors	Definition of coordination
Barnard (1938)	Action at the right place and the right time
Lawrence and Lorsch (1967a)	Resolution of intra-organisational goal conflict
Van de Ven et al. (1976)	Integrating or linking together different parts of an organisation
Malone and Crowston (1994)	Managing dependencies between activities
Heath and Staudenmeyer (2000)	Organising individuals so that their actions are aligned
Gulati et al. (2005)	An alignment of actions (but not necessarily an alignment of interest)
Faraj and Xiao (2006)	A temporally unfolding and contextualised process of input regulation and interaction articulation to realise a collective performance

Discussions of coordination often incorporate terms such as collaboration, cooperation and integration. While some researchers and practitioners may sometimes use these terms interchangeably, collaboration, cooperation and integration are conceptually separate ideas. Okhuysen and Bechky (2009) point out that cooperation implies a willingness to coordinate with each other whereas collaboration implies cooperation of a voluntary nature. Lawrence and Lorsch (1967a) define integration as the process of

achieving unity of effort among the various subsystems in the accomplishment of the organisation's task. More specifically, Gulati et al. (2005) define integration as encompassing not only coordination (alignment of actions) but also cooperation (alignment of interest). Generally, the common theme of these discussions refers back to the presence of joint behaviour toward some goal of common interest (Pinto et al., 1993).

An important implication of the distinction between coordination, cooperation, collaboration and integration is that in practice, internal departments may coordinate (or attempt to coordinate) among themselves but not necessarily in an entirely cooperative, collaborative or integrative manner, leading to very different organisational configurations and therefore outcomes. Moreover, coordination can be achieved even if interests between stakeholders are not aligned (Gulati et al., 2005).

2.1.2. Theories of the firm and the link to coordination

Coordination in economic theory

The role of coordination within a firm was perhaps first studied academically by economists. In a seminal work on firm theory, Coase (1937) notes that the act of coordination within a firm cannot be explained by the price mechanism as applied to markets. Rather, a firm consists of a system of relationships that arises from the direction of resources by an "entrepreneur". As the number of transactions to be organised increases, it may be more difficult to place the factors of production in the uses where their value is greatest. Coordination problems result, thereby limiting the growth and size of firms, which thus lead to the rise of formal organisations.

Barnard (1938) defines formal organisation as a system of consciously coordinated activities or forces of two or more persons. As a cooperative system, a formal organisation has three elements: communication, willingness to serve and common purpose. In particular, a system of communications and the authority of executives (i.e. authoritative communications) are central to the coordination of all aspects of the organisation.

Yet, extended forms of inter-firm coordination do not constitute the norm in most companies (Fawcett and Magnan, 2002) and some researchers/economists (e.g. Grover and Malhotra, 2003) attribute this to the phenomenon of transaction costs. Transaction cost theory states that opportunism, uncertainty and asset specificity in markets leads to high transaction costs that force firms to carry out coordinated adaption within the same organisation (Williamson, 1981; 1991). This also explains why some firms adopt vertical integration (Williamson, 1971), despite the challenges of internal coordination. This is especially in the case of changing circumstances in which mechanisms of price changes are not available to promote autonomous outcomes (Williamson, 1991), leading to the need to craft adaptive internal coordinating mechanisms related to complex contracting and internal organisation.

Interdependence and specialisation

As organisational complexity increases, uncertainty becomes another important variable in organisational theory. Uncertainties can arise from external sources (arising from a lack of understanding of cause/effect or environmental contingencies) or interdependence of internal components (Thompson, 1967). Such interdependent relationships can be divided into three types: pooled, sequential and reciprocal. Pooled

interdependence is a situation in which each part renders a discrete contribution to the whole and each is supported by the whole. Sequential interdependence exists if parts are directly interdependent and the order of interdependence can be specified. Reciprocal interdependence refers to the situation in which the outputs of each become inputs for the others. Each of these requires different "devices" to achieve coordination in functional groups that would minimise coordination costs. With pooled interdependence, coordination by standardisation is appropriate, with sequential interdependence co-ordination by plan is appropriate, and with reciprocal interdependence coordination by mutual adjustment is appropriate. For example, activities of a firm are linked by the competing use of the same pooled resources requires the coordination of resource-allocation and/or activities to improve resource utilisation.

Interdependence is increased when there is a greater degree of specialisation (of labour and capital) and process management. The knowledge-based theory of the firm argues that increasing the firm specificity of activities enhances the efficiency with which such activities are coordinated through internal governance (Poppo and Zenger, 1998), via common language, commonality of specialised knowledge, shared meanings and recognition of individual knowledge domains (Grant, 1996). To accomplish complex tasks, organisations typically create specialist functions (Galbraith, 1974; Grant, 1996; Heath and Staudenmayer, 2000). While this increases the productivity or effectiveness of those functions, it simultaneously creates disparate yet interdependent groups who may have different technologies/expertise as well as potentially different priorities and objectives. The importance of coordination increases as organisations become reliant on interdisciplinary teams of specialists (Grant, 1996; Faraj and Xiao, 2006). However, these groups and specialists may focus more on partitioning the task than they do on

integrating it or, they neglect the interrelationships and interactions among components (Heath and Staudenmayer, 2000), which contribute to "coordination neglect".

Coordination capability as a competitive advantage

While earlier theories of the firm view coordination (and its problems) as arising inevitably as organisations grow, this view has evolved to that of strong coordination as a trait that confers a firm an advantage in the market, especially as an industry matures and cost competitiveness becomes important. Porter (1980) observes that as a firm transitions from creating new products or markets to cost-control, more coordination across functions and among manufacturing facilities must often occur for the company to be cost competitive. For example, as an industry matures, regional plants that previously operated independently have to be better coordinated, requiring new systems, new procedures and changes to the coordinating role of plant managers (Porter, 1980).

The resource-based view theory of the firm focuses on unique, costly-to-copy or imperfectly imitable attributes of the firm as sources of economic rents and drivers of performance, competitive advantage and above-normal rates of return (Barney, 1986a, 1991; Conner, 1991; Grant, 1991; Mahoney and Pandian, 1992). Barney (1991) classifies firm resources into three categories: physical capital resources, human capital resources and organisational capital resources. In particular, organisational capital resources refer to a firm's formal reporting structure, its formal and informal planning, controlling, and coordinating systems, as well as informal relations among groups within a firm and between a firm and those in its environment. A limitation in the

resource-based theory, however, is the assumption that managers are limited in their ability to manipulate all the attributes and characteristics of their firms (Barney, 1991).

On the other hand, Dyer and Singh (1998) propose a relational view of competitive advantage that focuses on dyad/network routines and processes as an important unit of analysis. A firm's critical resources may span firm boundaries and may be embedded in inter-firm routines and processes. There are four potential sources of inter-organisational competitive advantage and relational rents, namely: (1) relation-specific assets, (2) knowledge-sharing routines, (3) complementary resources/capabilities, and (4) effective governance.

The common underlying theme across these theories is the goal of organisational coordination, even if the underlying associations are different in each of these theories (authoritative communications, interdependence, market opportunism, knowledge specialisation, competitive advantage and relational rents). Table 2-2 summarises the gist of each theory and the links with coordination. There is an observable trend whereby earlier theories view coordination as a necessity to be facilitated through authorities, hierarchies and formal organisations, towards the more recent view that strong coordination capabilities can be a source of competitive advantage.

Table 2-2: Links between Theories of the Firm and Coordination

Theory/Author	Context	Link with Coordination
Transaction cost view (Williamson, 1981; 1991)	Firms are susceptible to opportunism in the market when functions are externalised	Firms coordinate internally to avoid costly external transaction costs
Interdependence view (Thompson, 1967)	Interdependence of elements within an organisation requires concerted action, depending on whether the interdependence is of a pooled, sequential and reciprocal nature	The three types of interdependence can be handled via by standardisation, plan and mutual adjustment respectively
Resource-based view (Barney, 1986a)	Firms seek unique, costly-to-copy or imperfectly imitable attributes to maintain competitive advantages	Ability to coordinate internally or externally is a source of competitive advantage
Knowledge-based view (Grant, 1996)	Increasing firm specificity of activities increases efficiency via specialised work units	Specialised work units need to be coordinated
Relational view (Dyer and Singh, 1998)	Dyad/network effects across organisations create relational rents	Processes and routines used to coordinate between firms are a source of relational rents

2.1.3. Organisational design and the mechanisms of coordination

While theories of the firm explain why organisational coordination is needed, they tend to neglect or understate the mechanisms through which firms coordinate. In the field of organisational design, coordination mechanisms are "any administrative tools for achieving integration among different units within an organisation" (Martinez and Jarillo, 1989). Mintzberg (1979; 1980) identifies five mechanism of coordination that may explain the fundamental ways in which organisations coordinate their work: mutual adjustment, direct supervision, standardisation of work processes, standardisation of work outputs, and standardisation of worker skills. Martinez and Jarillo (1989) further classify mechanisms of coordination into two groups: structural and formal mechanisms, and other mechanisms (which are less formal and more subtle). Structural and formal mechanisms include departmentalisation, hierarchies, standardisation, planning and output control. Informal mechanisms include lateral or cross-departmental relations, informal communication and socialisation (Martinez and Jarillo, 1989).

It should be noted that inter-organisational coordination mechanisms are quite distinct from intra-organisational coordination mechanisms (Okhuysen and Bechky, 2009). For instance, the former set of coordination mechanisms can be classified as price, non-price, or flow mechanisms (Fugate et al., 2006), which would be less relevant in a single organisation context. Similarly, in a study on inventory coordination in decentralised supply chains, Piplani and Fu (2005) found that an inter-organisational incentive alignment mechanism (in the form of cost sharing and service level contracts) is needed for the value of coordination to be realised by each partner in a supply chain network. Furthermore, when coordination is applied to a large degree in an inter-organisational setting, supply chain integration may take place, such that a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organisation processes (Flynn et al., 2010).

2.1.4. Coordination and ambidexterity

At this point, it may seem that an organisation's ability to develop mechanisms to coordinate is directly linked to its success, or that physical/human resources are more valuable if they can be closely coordinated. Yet the literature suggests that it is possible for an organisation to become "over-coordinated".

Benner and Tushman (2003) observe that the influence of process management techniques on tightly coordinated processes can drive efficiency and incremental changes, but also lead to an organisational inertia in responding to more disruptive changes. Therefore, coordination may imply greater control and lower room for creativity, leading to a tension or even an inverse relationship between the degrees of

differentiation and integration in a firm (Lawrence and Lorsch, 1967a; Raisch et al., 2009).

However, recent research suggests that integration and differentiation (or alignment and adaptability) can be complementary, rather than alternative, means of achieving organisational effectiveness. For example, cross-functional teams which encourage social and technical interaction between developers and implementers can improve and promote creativity and innovation (Martins and Terblanche, 2003). Moreover, the relative balance between integration and differentiation is likely to vary with the specific task or activity at hand (Raisch et al., 2009).

Ambidextrous organisations are those capable of implementing not just evolutionary (i.e. incremental) and also revolutionary change. Superior performance is expected from ambidextrous organisations that have cultures that have "simultaneously tight and loose" social controls (Tushman and O'Reilly, 1996). In particularly, by encouraging individuals to make their own judgments as to how best divide their time between the conflicting demands for alignment and adaptability, organisations can simultaneously achieve alignment and adaptability (Gibson and Birkinshaw, 2004) via "contextual ambidexterity". Managers' participation in cross-functional interfaces can also in turn lead to higher degrees of ambidexterity on a personal level for managers (Mom et al, 2009). Organisational ambidexterity is also closely linked to the concept of bricolage, in which organisations engage in role shifting, reorganising routines and reordering in response to uncertain or surprising situations (Bechky and Okhuysen, 2011).

2.2. Supply Chain Coordination

The supply chain for an organisation can often be viewed as a microcosm of the relationships within that organisation. Like an organisation with its various internal and external stakeholders, a supply chain for a single product or service often involves representatives from multiple departments and tiers of suppliers. Supply chain coordination occurs when all stages of a supply chain work towards the objective of maximising total supply profitability based on shared information (Chopra and Meindl, 2016).

Supply chain coordination encompasses a broad area, including topics and theories such as the marketing-operations interface (MOI) and supply chain integration (SCI). The issue of new product development/introduction is also often a distinct topic focused on by some researchers, due to the tension between integration and differentiation (or exploration versus exploitation) in organisational coordination, as explained in the previous section. This section thus begins by providing an overview for the need for supply chain coordination and common types of supply chain coordination.

2.2.1. The need for supply chain coordination

In the supply chain context, there are several reasons why coordination is required, the key of which are that firms face uncertainty/equivocality and interdependence. The development and introduction of new products is probably a prime example of an instance in which a supply chain must deal with high degrees of uncertainty/equivocality and interdependence.

Uncertainty and equivocality

Most supply chains are equipped to handle predictable variability, which is the change in demand, such as seasonal patterns, that can be forecasted (Chopra and Meindl, 2016). However, managing uncertainties is more challenging, as they are often accompanied by a lack of information that can stem from unforeseeable risk events (such as natural disasters) and dependencies on other stages in a supply chain. From this standpoint, uncertainty can be defined as "the difference between the amount of information required to perform the task and the amount of information already possessed by the organisation" (Galbraith, 1977). Information asymmetry can also emerge from opportunistic behaviour of parties in the supply chain who may withhold information (Feldmann and Müller, 2003).

In modern supply chain designs, sources of uncertainty include the trends of global sourcing and lean methodologies, which increase supply chain risks. Christopher and Peck (2004) identify five categories of such risks, namely: process, control, demand, supply and environment. Separately, Van der Vorst and Beulens (2002) present the below typology of supply chain uncertainties, across the quantity, quality and time dimensions (Table 2-3).

Table 2-3: Typology of Supply Chain Uncertainties

	Quantity aspects	**Quality aspects**	**Time aspects**
Supply	Supply quantities	Supply qualities	Supplier lead time
Demand and distribution	Customer demand for product quantities	Customer demand for product specifications	Customer order distribution lead time
Process	Product yield and scrap; write offs	Produced product quality; product quality after storage	Product throughput times; storing time
Planning and control	Information availability	Information accuracy	Information throughput times

Source: Van der Vorst and Beulens (2002)

To handle challenges in the internal and external environments, organisations may adopt strategies and levers (e.g. internal buffering mechanisms of inventory, lead time or capacity) but these incur costs and can exacerbate the problem of internal uncertainty (Newman et al., 1993). Therefore, rather than using one-size-fits-all supply chain strategies, the right strategy would be contingent on demand and supply uncertainties, and based upon dynamically adjustments with information sharing and coordination (Lee, 2002b).

Besides uncertainty, organisations may also encounter equivocality. Equivocality refers to ambiguity and the existence of multiple and conflicting interpretations about an organisational situation, which may not be resolved by obtaining more data (Daft and Lengel, 1986). Equivocality is thus characterised by a lack of consensus (Frishammar et al., 2011) rather than a lack of information.

Interdependence

Drawing on the interdependence concept espoused by Thompson (1967), Dubois et al. (2004) point out that all three types of interdependence may occur in supply chains. First, the supply chain concept implies sequential interdependence among activities which need to be coordinated. Second, reciprocal interdependence may also occur when ex ante matching of plans is required and firms need to make the plans fit into their different production contexts via adjustments of resources to improve resource utilisation or the means of coordination. Third, the utilisation of common resources can help achieve economies of scale for individual activities that belong to different supply chains, but this introduces pooled interdependence, which requires the coordination of the joint utilisation of these resources (Dubois et al., 2004).

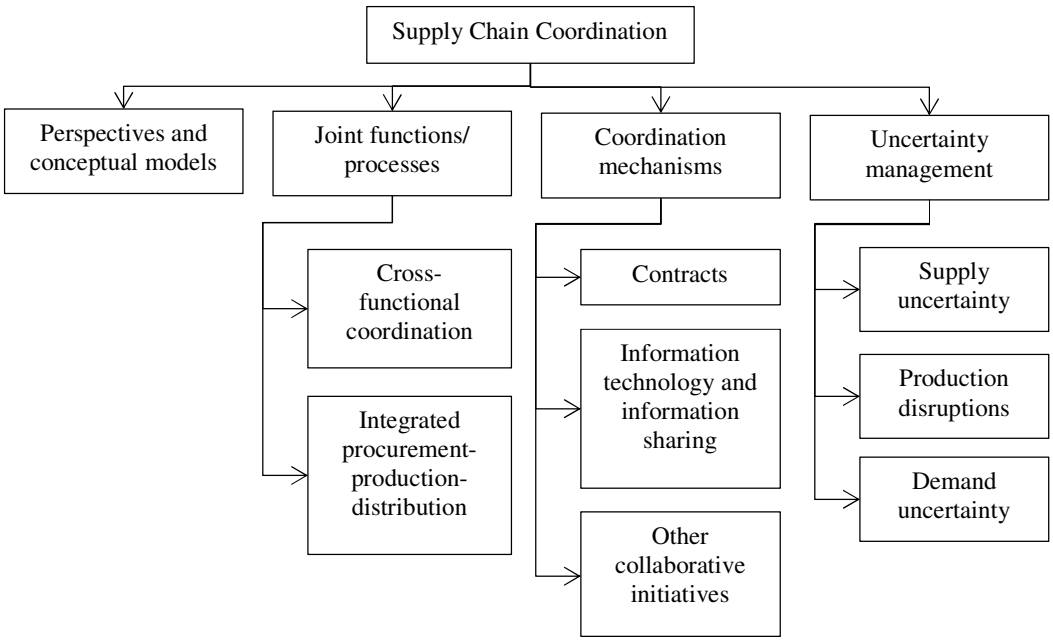
New product introduction

As Porter (1980) points out, rapid product changes or style changes demand quick response and intense coordination among functions, but they may lead to diseconomies of scale in large firms. Some studies thus suggest that supply chain coordination is particularly important in new product introductions. For example, Olson et al. (2001) examined patterns of cooperation and the level of functional integration for 34 recently developed products. Their findings reveal that higher project performance is demonstrated when cooperation between marketing and R&D, and cooperation between operations and R&D is high during early stages. Likewise, Petersen et al. (2005) observe that early supplier involvement is a key coordinating process in supply chain design, product design and process design, and can produce significant improvements in financial returns and/or product design performance.

Other researchers have focused on the coordinating mechanisms that impact new product development. Hauptman and Hirji (1999) studied coordination in the context of concurrent engineering in 50 cross-national teams and found that mechanisms, such as team-based rewards and job rotation, and coordination mechanisms, such as project structure and information technology, and project leader's management style, support an effective team process, and overcome the negative effect of geographic distance and time-difference. Calantone et al. (2002) surveyed 226 senior manufacturing engineers and plant managers in the automotive industry on the marketing–manufacturing interface in new product development. They found that knowledge and communications (knowledge transfer) are important positive antecedents of cross-functional harmony in highly uncertain environments.

2.2.2. Classification and typology of supply chain coordination

The presence of uncertainty, equivocality and inter-dependence has led to academic research to deal with these challenges, though the focus of supply chain coordination has continued to evolve as newer supply chain concepts emerge. Arshinder et al. (2011) provide the below classification scheme for supply chain coordination based on their review of the literature (Figure 2-1). As the classification scheme shows, supply chain coordination includes both internal coordination (which are cross-functional in nature) and external coordination (which can be facilitated by inter-firm contracts), underlined by the need to manage the underlying uncertainty in the supply chain.



Source: Arshinder et al. (2011)

Figure 2-1: Literature classification scheme for supply chain coordination

Table 2-4 further compares four key types of supply chain management coordination within the operations management literature. While there are clearly overlaps and

minimising cost is still a key consideration, these concepts of supply chain coordination have been developed somewhat independently by the academia and the industry, and tend to be rooted in different settings and scope. For example, Collaborative Planning, Forecasting and Replenishment (CPFR), a web-based attempt to coordinate between supply chain trading partners (Fliedner, 2003; Danese, 2006), is almost exclusively focused on a retailer-manufacturer setting (in which handling retail promotions in the food, apparel, and general merchandise industries are a key motivation for collaboration). On the other hand, S&OP closely resembles marketing-operations interface management, but the former is process-based (Milliken, 2008; Boyer, 2009; Bower, 2012b) while the latter tends to be analytical model-based (Tang, 2010).

Table 2-4: Typology of Supply Chain Coordination/Integration Concepts

Concept	Origin	Internal or External	Typical Research Themes	Typical Research Methods	Selected References
Marketing-operations interface (MOI)	Academic	Mainly internal, some external	Customer portfolio selection, guaranteed customer service, new product development, product assortment, production and pricing, channel coordination	Theoretical frameworks, analytical models	Sawhney and Piper (2002); Calantone et al. (2002); Tang (2010)
Supply chain integration (SCI)	Academic	Internal and external	Goal alignment, incentives design, new product development, supply chain resilience, relationship development, contingency	Theoretical frameworks, surveys, path/ structural models	Frohlich and Westbrook (2001); Pagell (2004); Flynn et al. (2010)
Collaborative Planning, Forecasting and Replenishment (CPFR)	Practitioner	External	Forecast accuracy, supply chain responsiveness, joint business plan, strategic retailer-manufacturer partnership	Conceptual frameworks, case studies	Fliedner (2003); Danese (2006)
Sales & Operations Planning (S&OP)	Practitioner	Mainly internal, some external	Consensus-building, integrated business plan, process design, maturity	Conceptual frameworks, surveys, case studies	Grimson and Pyke (2007); Oliva and Watson (2011); Tuomikangas and Kaipia (2014)

The next section presents an overview on the marketing-operations interface and supply chain integration, given the rich academic literature available on these topics, as well as the theoretical background that is relevant to S&OP.

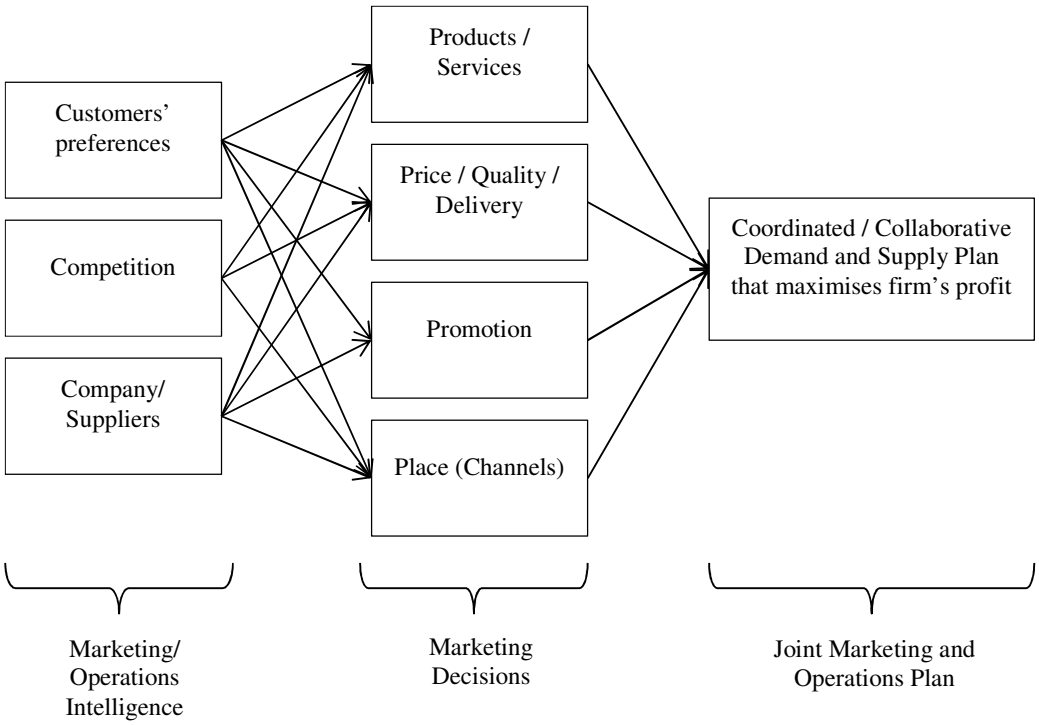
Marketing-operations interface (MOI)

The marketing-operations interface (also known as the manufacturing-marketing interface) can be viewed from the traditional demand versus supply perspectives (Tang, 2010). Marketing is an external-focused functional area that determines what products or services a company should provide through which channel at what price (i.e. the demand), whereas operations is largely an internal-focused functional area that examines how to deliver this demand by using internal or external resources (i.e. the supply). As such, the conflict between marketing and operations arises when the operation's supply' does not meet the marketing's demand (Tang, 2010).

Shapiro (1977) identifies eight problem areas in which manufacturing (operations) and marketing may come into conflict: long-term sales forecasting, short-term sales forecasting, physical distribution, quality assurance, breadth of product line, cost control, new product introduction and after sales services. To overcome them, he suggests mutual adaption of the corporate policies by the two functions, top management foster cooperation compromise and informal inter-functional contact (a precursor of sales and operations planning meetings).

To anticipate and respond to market dynamics better, the marketing and operations groups would need to go beyond coordination by jointly developing a collaborative plan with a joint performance measure (Tang, 2010), as depicted in Figure 2-2. Interactions

between functions would help make joint decisions on parameters such as lead time, quality, volume variation and product mix (Karmarkar, 1996).



Source: Tang (2010)

Figure 2-2: Coordinated/collaborative marketing and operations planning process

The effectiveness of a harmonious marketing-operations interface is also evident in the literature. Hausman et al. (2002) surveyed 390 executives and their results show that business performance is enhanced when the manufacturing and marketing functions are able to work together. Similarly, Stank et al. (1999) conducted a survey of 309 logistics managers in the United States to examine the marketing/logistics interface. Their results show positive associations between the frequency of collaborative integration between marketing and logistics departments and logistics managers' perceptions of the

effectiveness of the relationship between departments, as well as, departmental performance relative to competitors.

Supply chain integration (SCI)

Flynn et al. (2010) define supply chain integration (SCI) as the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organisation processes. Therefore, SCI may be viewed as a more extensive form of inter and intra-firm linkages, beyond those between the marketing and operations functions. Designing incentives is one option advocated in supply chain integration (e.g. Simatupang et al., 2002).

Supply chain integration can be classified as internal and external integration, which have different roles in getting supply chain members to act in a concerted way, to maximise the value of the supply chain. Functional integration and international integration have been described as stages two and three of a four-stage integration of a supply chain (Stevens, 1989). Internal (or intra-firm) integration recognises that the departments and functions within an organisation should function as part of an integrated process, while external integration recognises the importance of establishing close, interactive relationships with customers and suppliers (Flynn et al., 2010).

Internal integration is usually associated with cross-functional coordination, process interfaces and knowledge-sharing. If a firm is well-integrated, the costs of scheduling, coordinating operations, and responding to emergencies may be lower (Porter, 1980). This is corroborated by the results of Newman et al. (1993)'s study, which found that increased intra-firm integration increases manufacturing flexibility as well as decreasing the internal and external uncertainty faced by the firm. This in turn allows

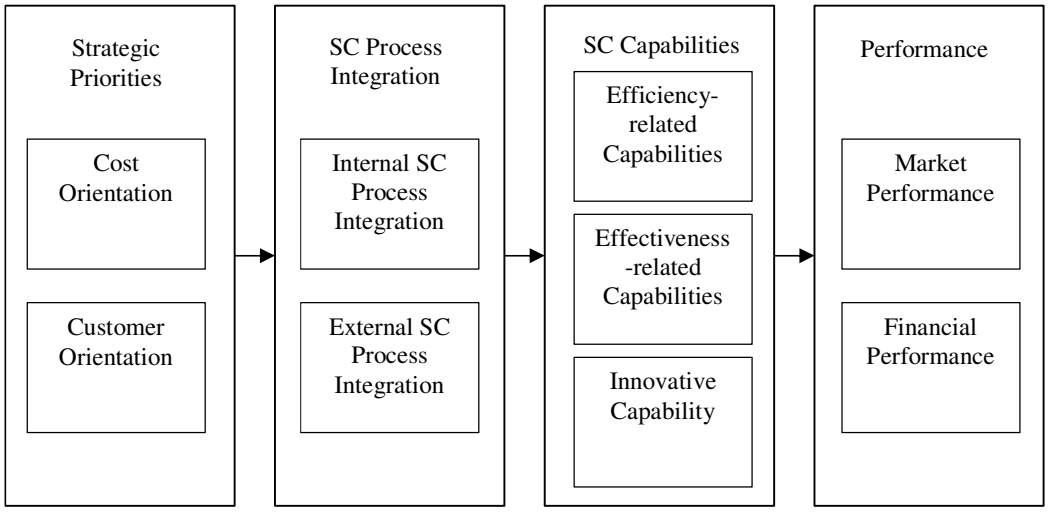
the firm to decrease its dependence on buffers and thus the complexity and uncertainty that it must deal with.

On the other hand, examples of inter-firm integration include virtual integration with customers or suppliers as well as inter-firm knowledge-sharing. Empirical evidence on the benefits of external integration has been widely reported. For example, Vickery et al. (2003) studied 150 first-tier automotive suppliers in North America and found evidence of positive direct relationships between (1) integrated information technologies and supply chain integration, (2) supply chain integration and customer service, and (3) customer service and firm performance. Likewise, Frohlich and Westbrook (2001) found that firms that have the widest degree of integration with both suppliers and customers had the strongest association with performance improvement. Prajogo and Olhager (2012) also found significant links in a path model that links long-term relationships, information technology and sharing, and logistics integration. Wong et al. (2011) conducted a survey and tested a theoretical model of the contingency effects of environmental uncertainty on the relationships between supply chain integration and operational performance. Their results show that under a high environment uncertainty, supplier/customer integration strengthens delivery and flexibility performance while internal integration strengthens product quality and production cost.

Although internal and external integration are conceptually different, some researchers suggest that internal integration positively affects external integration and that both are synergistic. Zhao et al. (2011) surveyed a wide range of industries in China and found that internal integration and relationship commitment independently improve external integration, although internal integration has a much greater impact on external integration than relationship commitment. Droge et al. (2004)'s study of automotive

suppliers in North America also found that not only are internal and external integration related to firm performance, their interaction is significantly related to both market share and financial performance.

While the link between integration and performance is somewhat well-supported by empirical evidence, empirical studies on the antecedents of "good" integration are less common compared to studies of a more conceptual nature. For example, Chen et al. (2009) propose a conceptual model (Figure 2-3) which postulates that a firm's strategic priorities (characterised by its cost and customer orientations) have a direct positive impact on its integration of supply chain process internally and externally, which in turn increases the firm's supply chain capabilities and performance.

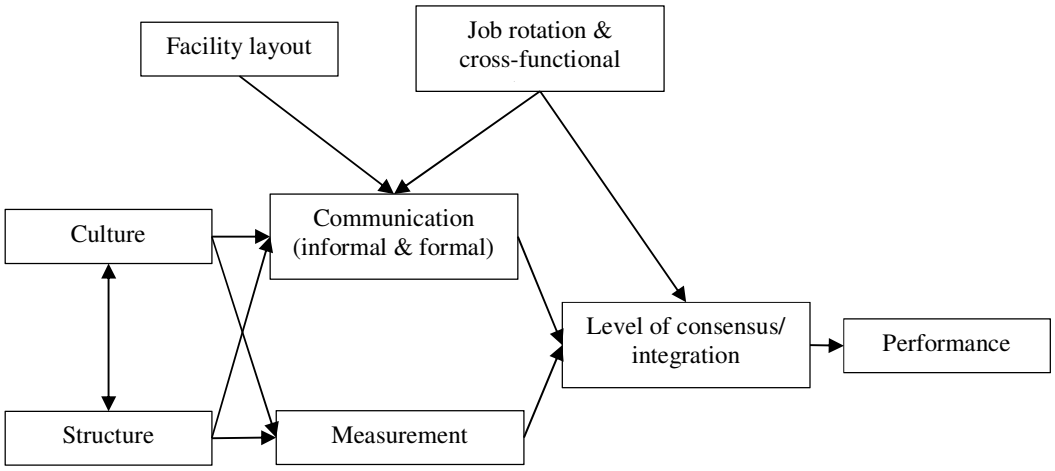


Source: Chen et al. (2009)

Figure 2-3: Conceptual Model for Supply Chain Process Integration

Based on an interview study of 11 companies across various industries and a review of literature, Pagell (2004) proposes a model of internal supply chain integration (Figure 2-4) which posits that organisational culture and organisational structure are important

antecedents in internal supply chain integration. In particular, plants with mechanised structures and cultures that are very functionally oriented tend to discourage communication across functions and encourage the creation of measures that optimised locally instead of globally. This in turn leads to a lower level of internal integration and therefore performance. However, Pagell (2004) suggests that information technology on its own cannot increase the level of integration in a plant.



Source: Pagell (2004)

Figure 2-4: Model of Internal Supply Chain Integration

Turkulainen et al. (2017) interviewed 51 supply chain management executives from 24 global manufacturing firms on the requirements and mechanisms for internal supply chain integration (SCI). They found four patterns of integration mechanism, namely:

- management of knowledge creation through all impersonal and personal mechanisms
- management of knowledge sharing through standardisation and personal mechanisms

- management of goal alignment through impersonal mechanisms and teams and integrator roles
- management of interdependencies and synergies through impersonal mechanisms and teams

These academic studies of the mechanisms of internal supply chain integration thus lead to the discussion on Sales and Operations Planning (S&OP), which has been developed largely by the industry.

2.3. Sales & Operations Planning

S&OP has its roots as a set of processes that evolved from aggregate production planning and forecasting, and passed information from higher level plans to lower-level, more detailed planning activities (Singhal and Singhal, 2007; Bower, 2012b). It was later adopted and further developed by practitioners in the discrete manufacturing industries (Noroozi and Wikner, 2017).

First, a brief overview of the scope and benefits of S&OP is presented, followed by a discussion of S&OP as a means of coordination, its place in organisational integration and S&OP maturity models. Finally, researchers have recently begun to question the generality of the S&OP methodology and therefore an overview on S&OP in relation to contingency and uncertainty variables in the supply chain is provided.

2.3.1. Scope and benefits of S&OP

As Chopra and Meindl (2016) explain, "Sales and operations is the process of creating an overall supply plan (production and inventories) to meet the anticipated level of

demand (sales). The S&OP process starts with sales and marketing communicating their needs to the supply chain, which in turn communicates to sales and marketing whether the needs can be met and at what cost. The goal of S&OP is to come up with an agreed upon sales, production, and inventory plan that can be used to plan supply chain needs and project revenues and profits. The S&OP plan becomes a critical piece of information to be shared across the supply chain because it affects both the demand on a firm's suppliers and the supply to its customers."

Therefore, it is not just supply planning that is important, but also capacity planning. From the supply planning perspective, S&OP can be viewed at the tactical level, in production volumes per product family, target levels of stock (both operational and safety), transport parameters (truckload or less-than-truckload, mode), average capacity utilisation, cost and cash requirements for the next planning period (Van Landeghem and Vanmaele, 2002). From the capacity planning perspective, a production plan is developed based on a sales plan at the S&OP level and translated into a capacity requirement plan in terms of aggregate resources. Under- and over-capacities are identified during S&OP and timing of capacity adjustments are then planned to optimise asset utilisation (Olhager et al., 2001; Hahn and Kuhn, 2012).

Furthermore, S&OP can be classified based on dimensions along which firms are integrated. Noroozi and Wikner (2017) reviewed the S&OP literature and classified the scope of S&OP research into several categories: Horizontal integration (involving supplier actors, demand planning, supply planning, balance, customer actors or competitors), vertical integration, financial integration and risk/scenario management. Accordingly, the benefits of S&OP may accrue to various aspects of supply chain performance, as summarised in Table 2-5. However, various researchers have pointed out a need for greater empirical evidence of S&OP effectiveness (e.g. Thomé et al.,

2012a; Tuomikangas and Kaipia, 2014; Qi and Ellinger, 2017; Noroozi and Wikner, 2017).

Table 2-5: Benefits of S&OP

Benefits	Selected supporting literature
Reduced lead time to customers	Collin & Lorenzin (2006); Nakano (2009)
Reduced stock-outs or back-orders	Schrieber (2005); Wallace (2006); Chase (2013)
Reduced inventory	Muzumdar & Fontanella (2006); Boyer (2009); Lapide (2004b)
Increased responsiveness to changes in demand	Ling & Goddard (1988); Harwell (2006); Bower (2012b); Hadaya & Cassivi (2007); Mello & Stahl (2011); Chase (2013)
Increased responsiveness to disruptions in supply	Schrieber (2005); Smith et al. (2010); Ivert & Jonsson (2010)

2.3.2. S&OP maturity models

Extensions of the traditional S&OP model have given rise to several attempts to classify S&OP implementations according to the level of maturity (e.g. Lapide, 2005; Grimson and Pyke, 2007; Cacere et al., 2009; Wagner et al., 2014). As Table 2-6 shows, these researchers tend to associate mature forms of S&OP with proactive teams that integrated with information technologies and occasionally with external supply chain partners, yet such mature forms of S&OP are practised by few firms (Grimson and Pyke, 2007; Barrett and Uskert, 2010). Practitioners also occasionally use the term "Integrated Business Planning" (IBP) to denote advanced versions of S&OP (Bower, 2012a) and large organisations tend to have more mature processes, such as in demand planning (Vereecke, et al., 2018). It is also apparent from Table 2-6 that S&OP maturity is commonly associated with more formally-integrated organisations and reduced negative effects of differentiation, but as Oliva and Watson (2011) point out, this approach has its limits, since functional differentiation is a natural response by managers to "a limited span of surveillance that forces them to focus on only a portion of their total environment or the needs of only certain stakeholders".

Table 2-6: Comparison of Key Attributes of S&OP Maturity Models

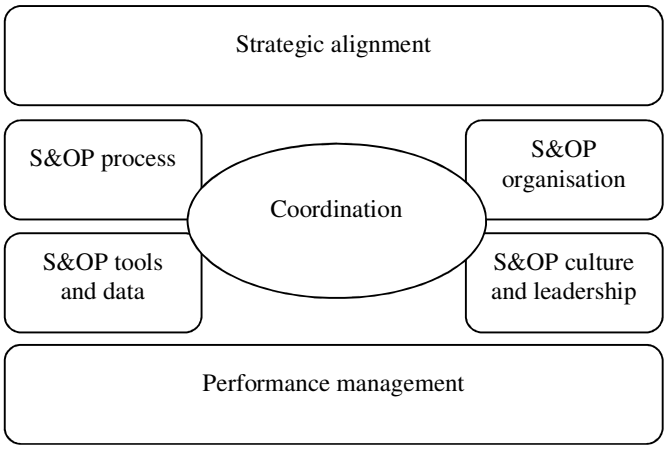
Authors \ Maturity	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Lapide (2005)	***Marginal***	***Rudimentary***	***Classic***	***Ideal***	NA
	Informal meetings, disjointed processes, minimal technology enablement	Formal meetings with spotty attendance and participation, interfaced processes, standalone applications interfaced	Formal meetings with full attendance and participation, integrated processes, applications integrated	Event-driven meetings, extended processes, full set of integrated technologies	
Grimson and Pyke (2007)	***Reactive***	***Standard***	***Advanced***	***Proactive***	NA
	Top level management meetings, no formal S&OP function, operations measured according to sales plan, spreadsheet-based IT, sales plan drives operations	Executive S&OP meetings, S&OP within other functions, forecast accuracy measured, centralised information, Some plan integration and sequential process	Participation by suppliers/ customers, formal S&OP team, NPI and S&OP performance measured, operations optimisation linked to ERP, integrated plans with collaborative two-way process	Event driven meetings, S&OP part of organisation mindset, company profitability measured, integrated S&OP optimisation and ERP, seamless integration of plans	
Cacere et al. (2009)	***Reacting***	***Anticipating***	***Collaborating***	***Orchestrating***	NA
	Focus on sales versus factory capabilities	Focus on sales and marketing plans versus planning and factory capabilities	Focus on go-to-market plans versus design of demand-driven plan, make, and deliver processes	Focus on go-to-market strategies versus translation of demand into plan, make, deliver, source, and service strategies	

Authors \ Maturity	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Wagner et al. (2014)	***Rudimentary***	***Reactive***	***Consistent***	***Integrated***	***Proactive***
	Slightly formalised planning, decentralised information, no clear role descriptions, organisation not aligned with business), isolated demand and supply planning systems	Moderately formalised planning, routinely scheduled meetings, partially centralised information, roles and responsibilities clearly defined, demand planning software and production planning systems	Formalised planning processes generally, routinely scheduled meetings, relevant information shared, dedicated S&OP process owner established, multi-facility APS system in place	Highly formalised planning processes internally, routinely scheduled and event-driven meetings, inter-departmental flow of information planning organisation aligned with business, systems keep track of plans and exceptions	Formalised planning process throughout supply chain, event-driven meetings, external participants integrated via systems, dedicated S&OP process owner, systems/tools integrate supply chain partners

2.3.3. Coordinating mechanisms of S&OP

While the S&OP maturity models advocate templatised maturities that companies should aim for, the impact that the individual determinants of maturity is not well understood. For example, it is not clear whether a firm that falls short in one aspect of maturity will experience shortfalls in performance, regardless of how well it rates in the other aspects.

To address the shortcomings of S&OP maturity models, research focus in the literature has evolved from conceptual models of maturity to the workings of individual mechanism of effective S&OP. For example, Thomé et al. (2014a & 2014b) proposed a model that uses four mechanisms (meetings and organisation, measurement, technological integration and integration of plans). Tuomikangas and Kaipia (2014) proposed a similar, but more comprehensive, S&OP coordination framework as shown in Figure 2-5.



Source: Tuomikangas and Kaipia (2014)

Figure 2-5: S&OP Coordination Framework

An independent review of the S&OP literature as part this thesis also found that Tuomikangas and Kaipia (2014)'s framework is well-supported by the literature, as shown in Table 2-7.

Table 2-7: Attributes of S&OP Coordination Mechanisms According to Literature

Construct	Attribute	Selected Supporting Literature
Organisation	There is a formal team involved in S&OP meetings	Ling & Goddard (1988); Lapide (2004a); Grimson & Pyke (2007); Swaim et al. (2016); Pedroso et al. (2016)
	There is a designated owner(s) for the S&OP process	Grimson & Pyke (2007); Iyangar & Gupta (2013); Wagner et al. (2014); Tuomikangas & Kaipia (2014)
	Each participant in S&OP meetings has clear roles and responsibilities	Lapide (2004a); Lapide (2007) Wagner et al. (2014); Tuomikangas & Kaipia (2014)
S&OP Process	There is a defined common S&OP calendar within the company, as part of the S&OP process	Lapide (2004a); Bower (2005); Boyer (2009); Milliken (2008); Smith et al. (2010); Tuomikangas & Kaipia (2014); Alexander (2016)
	S&OP meetings or conference calls follow a standard process/format	Lapide (2004a); Bower (2005); Ivert & Jonsson (2010), Oliva & Watson (2011); Thomé et al. (2012a); Tuomikangas & Kaipia (2014); Swaim et al. (2016); Ambrose & Rutherford (2016)
	S&OP meetings or conference calls are conducted at least once a month	Ling & Goddard (1988); Lapide (2004a); Grimson & Pyke (2007); Smith et al. (2010); Alexander (2016)

Construct	Attribute	Selected Supporting Literature
S&OP tools and data	It is easy to share, retrieve or update S&OP-related data within the organisation	Grimson & Pyke (2007); Milliken (2008); Tuomikangas & Kaipia (2014); Kaipia et al. (2017)
	S&OP is enabled by IT tools that are used in creating operational plans	Lapide (2004a); Lapide (2004b); Grimson & Pyke (2007); Affonso et al. (2008); Ivert & Jonsson (2010)
	S&OP data collected is of a high standard	Ling & Goddard (1988); Grimson & Pyke (2007); Ivert & Jonsson (2010); Tuomikangas & Kaipia (2014); Ambrose & Rutherford (2016)
	S&OP data requirements are well-defined	Ling & Goddard (1988); Schrieber (2005); Stahl (2010); Tuomikangas & Kaipia (2014); Ambrose & Rutherford (2016)
Performance Management	S&OP performance metrics have multiple dimensions from the financial, operations or process perspectives	Ling & Goddard (1988); Grimson & Pyke (2007); Milliken (2008); Iyangar & Gupta (2013); Tuomikangas & Kaipia (2014)
	Targets derived using the S&OP process is tracked against actual performance	Ling & Goddard (1988); Lapide (2004a); Bower (2005); Thomé et al. (2012a); Milliken (2013); Wagner et al. (2014)
	S&OP performance metrics balance between the interests of various parties in the organisation	Grimson & Pyke (2007); Stank et al. (2011); Thomé et al. (2012b); Tuomikangas & Kaipia (2014)
	Performance issues and bottlenecks are effectively addressed and followed-up upon after S&OP meetings	Bower (2005); Milliken (2008); Tuomikangas & Kaipia (2014); Van Hove (2016)
Strategic Alignment	S&OP supports the entering of new markets or on-boarding of new customers	Muzumdar & Fontanella (2006); Mello & Esper (2007); Tuomikangas & Kaipia (2014)
	S&OP supports the coordination of new product introductions	Olhager et al. (2001); Wallace (2006); Tuomikangas & Kaipia (2014)
	There is two-way feedback between strategic plans and S&OP plans	Lapide (2011); Tuomikangas & Kaipia (2014); Van Hove (2016)
Organisational Culture & Leadership	There is trust among employees or departments within the company	Hadaya & Cassivi (2007); Mello (2010); Oliva & Watson (2011); Thomé et al. (2012a); Tuomikangas & Kaipia (2014)
	Employees are empowered to contribute actively to the company's plans at various levels	Ling & Goddard (1988); Lapide (2004a); Lapide (2005); Muzumdar & Fontanella (2006); Oliva & Watson (2011); Thomé et al. (2012a); Tuomikangas & Kaipia (2014); Wagner et al. (2014)
	There is effective communications of business objectives and vision within the company	Godsell et al. (2010); Tuomikangas & Kaipia (2014); Van Hove (2012 & 2016)
	Top management is supportive of S&OP	Grimson & Pyke (2007); Thomé et al. (2012a); Tuomikangas & Kaipia (2014); Van Hove (2012)

Other potential mechanisms from organisation theory

In the organisation science literature, there are several other potential coordination mechanisms, beyond those in Thomé et al. (2014a & 2014b) and Tuomikangas and

Kaipia (2014), though they appear to be less important from an S&OP perspective. These mechanisms include:

- ***Proximity***. A traditional view of physical organisations is that individuals are most likely to interact and communicate with others when individuals work near each other (Pinto et al., 1993; Okhuysen and Bechky, 2009). However, two past studies found that the physical proximity construct has an insignificant link with the effectiveness of cross-functional cooperation (Pinto et al., 1993) and with new product performance in a product development setting (Sethi, 2000). Advances in electronic communication have "obviated" the need for physical proximity of nodes to achieve horizontal coordination (Fulk and DeSanctis, 1995). Besides, in an increasingly globalised environment, it is no longer always realistic for members within the same firm to be co-located. The notion of a "Global" S&OP implies the participation of cross-regional teams that are "scattered around the world" (Pedroso et al., 2016) and therefore *not* in close physical proximity.
- ***Familiarity***. In the literature on coordination, familiarity is focused on task-related information and knowledge that is acquired through direct experience working with others (Okhuysen and Bechky, 2009). Increased familiarity leads to stronger relationships, which encourages individuals to embrace their interdependence and allow them to more effectively coordinate (Gittell, 2002). Workers that have the *experience* of working together previously may also be more productive (Goodman and Leyden, 1991). In Hult et al. (2004)'s study on knowledge development in the supply chain, "knowledge", "experience" and "familiarity" are used as measurement items within the

same construct of "achieved memory". Familiarity is therefore closely related to *experience*, which in the context of S&OP could be indirectly (albeit imperfectly) inferred from the number of years that an organisation has implemented S&OP. Given the difficulty of objectively measuring degrees of "familiarity" within an organisation and across industries or geographies, years of S&OP experience at a business unit would probably be an appropriate proxy for familiarity.

- ***Cohesion.*** In the literature on cross-functional integration, cohesion (also known as cohesiveness or social interaction) can be defined as the strength of group members' interpersonal (i.e. informal) ties to one another. It could be of interest as a possible predictor for group performance, with the rationale that cohesiveness impacts upon performance by enhancing coordination and "lubricating" the group as a social system, (Mullen and Cooper, 1994). For example, Tsai (2002) found that informal lateral relations, in the form of social interaction, have a significant positive effect on knowledge sharing among internal business units, but this is provided they are not competing with each other for internal resources. However, Mullen and Cooper (1994)'s analysis suggests that while the link does exist, the cohesiveness-performance effect weakens when group size increases and that more importantly, the more direct effect may be from performance to cohesiveness (rather than from cohesiveness to performance). More recently, Ambrose and Rutherford (2016) found an insignificant direct link between cohesion and S&OP effectiveness.

2.3.4. Variables and contingency in S&OP

Despite the attractiveness of S&OP as a generic supply chain coordination process, the S&OP literature increasingly recognises that S&OP is contingency dependent (Ivert and Jonsson, 2010; Oliva and Watson, 2011; Thomé et al., 2012b; Ivert et al., 2015). Kristensen and Jonsson (2018) reviewed 68 papers published between 2000 and 2017 and found that S&OP design depends on industry, dynamic complexity, detail complexity and organisational characteristics. In particular, they found that the literature related to dynamic complexity has focused on the effects of demand and supply uncertainties on S&OP design, and that the practitioner literature predominantly focus on using scenario planning as a response variable to demand and supply uncertainty and to manage risk and achieve consensus.

Similar to the literature on the marketing-operations interface, there are two main approaches used in past studies on contingency factors in S&OP. The first approach uses quantitative analytical (operations research) approaches to model uncertainty and contingency factors, while the second approach uses empirical methods such as case studies and surveys.

Operations research (OR) methods, when applied to solving problems with the objective of maximising profits or minimising costs, have been used quite extensively to model the benefits of coordination and trade-offs in S&OP. For example, Feng et al. (2008) present a modelling approach to evaluate the impact of sales and operations. Their results show that a multi-site supply-chain-based S&OP that integrates the cross functional planning of sales, production, distribution, and procurement centrally provides superior performance to the cases when distribution and procurement are performed locally or when all functions are decoupled, particularly in a varying demand and/or market price environment. Similarly, Wang et al. (2012) proposed a global

S&OP planning framework to integrate four supply chain stages of demand, purchasing, production and transportation with different planning strategies, as well as a heuristic model that can be applied as a decision support tool to execute what-if analysis, hence enhancing coordination between financial and physical activities. Darmawan et al. (2018) present a decision-support model for a sales and operations plan (S&OP) that integrates production and price promotion planning decisions, to examine how the benefits of coordination are affected by various production- and marketing-related factors (such as flexibility in production capacity, seasonality, brand loyalty and promotion effect).

OR methods are also especially useful for conducting scenario planning of uncertainty variables. Van Landeghem and Vanmaele (2002) introduced the concept of robust planning, which applies risk assessment to S&OP within demand and supply chains. It employs Monte Carlo simulation as a part of the tactical planning calculation to assess the effects of uncertainty. Chen-Ritzo et al. (2010) approached the problem of problem of aligning demand and supply in configure-to-order systems within S&OP via stochastic programming methods. Their results show that significant improvements in revenue and serviceability can be achieved by appropriately accounting for the uncertainty associated with order configurations. Sodhi and Tang (2011) present a stochastic programming model that determines the supply requirement in an S&OP process while optimally trading off risks of unmet demand, excess inventory, and inadequate liquidity in the presence of demand uncertainty.

On the other hand, the empirical approach is more appropriate when contingency variables are non-quantifiable (or are difficult to quantify), such as across organisations in different industries or operating complexities. For example, Thomé et al. (2014b) found that operational performance is amplified by process complexity, such that the

more complex the manufacturing processes, the larger the gains of S&OP. Ivert et al. (2015) analysed eight case studies in the food industry and found that environmental contingencies (demand/supply uncertainty, frequency of product launches, and production network complexity) have a particularly important impact on S&OP design. Finally, Kaipia et al. (2017) present two case studies and show that companies may reap very different benefits from collaborative planning, due to different product types, forecasting update cycles, production planning cycles, demand pattern and trust in the efficiency of the use of point-of-sales data, which would in turn lead to varying amounts of 1) reduced lead-time to change production; 2) reduced lead-time to react to realised sales in forecasts; and 3) focused planning efforts (Kaipia et al., 2017).

2.4. Implications from Literature

Based on above presentation of the theoretical foundations, several key insights from the literature (and their implications on the current research for this thesis) can be synthesised.

2.4.1. S&OP as a tool to reduce equivocality

Organisation design theory provides much of the foundation on coordination and thus has theoretical relevance to S&OP. Early definitions of coordination focus on the notion of compromise or truce (Shapiro, 1977), or to bring conflict under control (Lawrence and Lorsch, 1967a). Later definitions shifted to mutually beneficial outcomes via alignment of goals and actions (e.g. Gulati et al., 2005). Moreover, coordination can be viewed from two economic perspectives. The first view (based on transactions-cost theory) states that firms coordinate internally as a matter of necessity, while the second

view (based on resource-based theory) states that firms that could eventually master coordination would gain a competitive advantage over those that couldn't.

Yet, it is clear from the perspective of conflict management that internal integration goes beyond the collection and sharing of information to obtain a competitive edge (Pagell, 2004). Rather, it depends on how this information is interpreted and utilised by a cross-functional team, even if each unit within such a cross-functional team may have its own incentives (Sodhi and Tang, 2011; Oliva and Watson, 2011). Uncertainty attributed to demand, supply or production disruptions (Arshinder et al., 2011) may be the impetus for information-sharing in the supply chain, but resolving equivocality is the raison d'etre for achieving consensus across functions (Frishammar et al., 2011). An effective means of supply chain coordination (such as S&OP) should therefore have the ability to handle not just uncertainties but also equivocality, which are often embodied by destabilising events such as new product introduction in the supply chain.

This leads to the important question (linked to ***TQ1***) of whether S&OP is merely a tool to manage organisational conflicts (which may bring about intangible benefits) or whether S&OP can bring about *measurable* improvements in performance in the supply chain.

2.4.2. S&OP maturity models and their deficiencies

The literature has seen the rise in popularity of multiple (and often duplicative) maturity models of S&OP (e.g. Lapide, 2005; Grimson and Pyke, 2007; Cacere et al., 2009; Wagner et al., 2014). These models describe S&OP as highly process-based, but how the processes within S&OP work is not well-elaborated upon. For example, from an input-process-output perspective, S&OP maturity does not directly impact

performance, but rather through certain coordinating mechanisms. S&OP maturity is hence merely indicative of the state of coordinating mechanisms in an S&OP programme but is not the underlying cause of S&OP effectiveness. Yet, structural and path models that link S&OP coordinating mechanism with S&OP outcomes are generally lacking to test the relationships asserted by conceptual studies or those by practitioners. It is especially unclear how S&OP outcomes would be impacted if only some drivers described in S&OP maturity models are present. Moreover, the "one-size-fits-all" design descriptions of the S&OP maturity models are not adequate for all contexts (Kristensen and Jonsson, 2018). There is therefore a gap in the literature on how S&OP programmes would perform within a variety of environmental settings and organisational ambiguity from the contingency theory perspective.

Another common thread that runs through these maturity models is that the degree of organisational integration is generally viewed to be positively correlated with maturity. In other words, S&OP is often associated with integration, while differentiation is to be discouraged (Oliva and Watson, 2011). Differentiation and integration may appear to be fundamentally at odds, but yet differentiation is often linked to positive organisation traits (such as innovation). The broader management literature (e.g. Tushman and O'Reilly, 1996; Benner and Tushman, 2003; Gibson and Birkinshaw, 2004; Raisch et al., 2009) is starting to appreciate a more ambivalent view of integration/differentiation. However, with few exceptions such as the paper by Oliva and Watson (2011), such an ambidextrous approach is still uncommon in the S&OP operations management literature.

The above deficiencies of S&OP maturity models are therefore to be addressed by ***TQ2***, which is related to the context-based efficacies of S&OP coordinating mechanisms.

2.4.3. Parallels with supply chain integration and the marketing-operations interface

As previously highlighted, S&OP originated from the industry and unsurprisingly, literature review studies of S&OP (e.g. Tuomikangas and Kaipia, 2014; Noroozi and Wikner, 2017; Kristensen and Jonsson, 2018) routinely turn up high percentages of practitioner-based studies. On the other hand, literature reviews (e.g. Tang, 2010) on supply chain integration and the marketing-operations interface show that these fields are relatively more academically driven.

While these concepts have developed independently from different sides of the practice/academic divide, they are linked by a common theme of coordination/collaboration and the objective of improving performance in the supply chain. However, there are also some key differences. First, within the SCI literature, there is a preponderance of emphasis on external integration over internal integration, while the converse is true of S&OP. Yet, while S&OP emphasises cross-functional coordination, it does not preclude the participation of external stakeholders when viewed through the lens of supply chain integration. Second, path models and analytical models within the SCI/MOI literature are relatively more sophisticated and underpinned by theories from both the management and organisation sciences, compared to those in the S&OP literature (especially the practitioner literature, which tends to be more prescriptive in nature).

Yet, the above differences only serve to draw attention to a relative lack of studies in the operations management literature that bring S&OP within the ambit of supply chain coordination. The parallels between S&OP and MOI/SCI also suggest that the academic

foundations of MOI/SCI can potentially be borrowed to frame, explain and extend the theoretical foundations of S&OP. In particular, the empirical models of SCI/MOI based on organisational theory could prove valuable in addressing ***TQ3***, on the role of organisational culture as an antecedent in S&OP implementations.

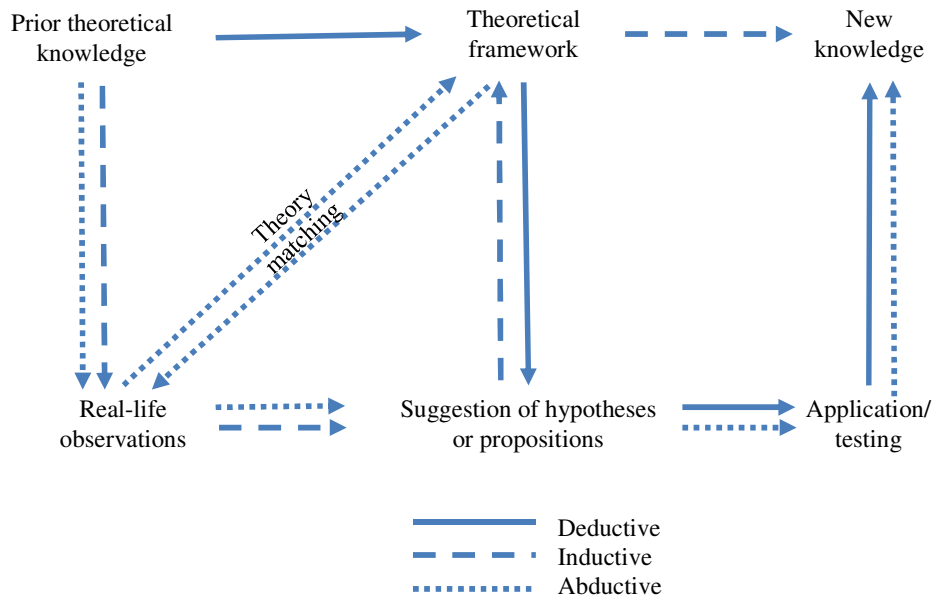
Chapter 3 – Research Design and Methodology

This chapter provides the background to the research approaches that are relevant to this thesis and empirical research in Operations Management (OM) generally. The inductive, deductive and abductive reasoning approaches to research are first introduced, followed by an overview of the case study and survey methods. The analytical concepts of fit (in the context of the design of structural models) are then discussed. Some key methodological implications on the design of the papers in the next three chapters are highlighted, before a conceptual research framework for this thesis is presented.

3.1. Research Approaches

There are generally three approaches to research, namely induction, deduction and abduction (Spens and Kovács, 2006; Mantere and Ketokivi, 2013). As Spens and Kovács (2006) explain, induction is a *theory development* process that begins with observations of specific instances and seeks to establish generalisations about the phenomenon under investigation. On the other hand, deduction is a *theory testing* process that seeks to see if an established theory or generalisation applies to specific instances. Abduction, which is the least known of the three approaches, is a process of *reasoning from effect to probable causes or explanations* that could be further verified via induction (Spens and Kovács, 2006). The general logic of abductive reasoning is thus to turn "surprising facts" into matters of course, which is how new hypotheses may be derived (Mantere and Ketokivi, 2013). In summary, deduction can be understood as an inference to an observation, induction an inference to a generalisation, and abduction

an inference to an explanation (Mantere and Ketokivi, 2013). Figure 3-1 illustrates the paths of reasoning used in these three approaches.



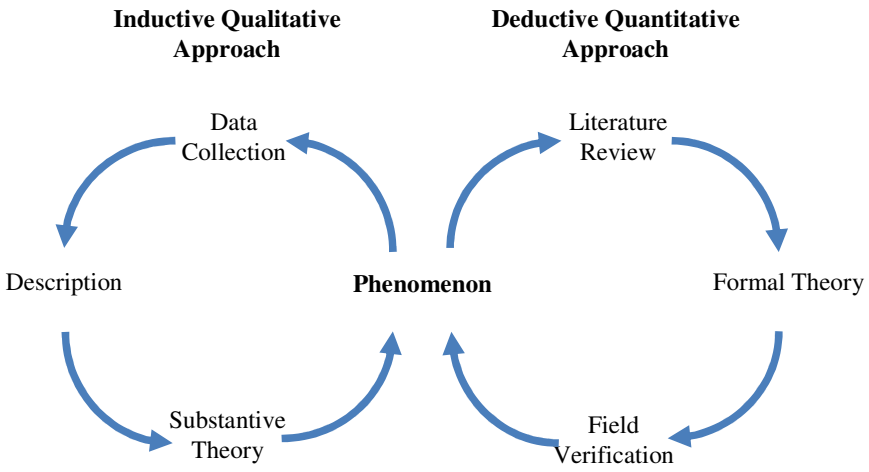
Source: Adapted from Spens and Kovács (2006)

Figure 3-1: Deduction, Induction and Abduction Research Approaches

Some researchers (e.g. Swamidass, 1991; Spens and Kovács, 2006) have observed that deductive research in the field of OM is generally more established (compared to the other two approaches), with a strong emphasis on the survey method. Yet, other researchers such as Golicic et al. (2005) point out that business environments in which supply chains operate are becoming increasingly complex and less amenable to using any one research approach. In order to accurately describe, understand and explain these complex phenomena, researchers should conduct more studies using multiple methods. Accordingly, there is a need for a more balanced approach to research using inductive research methods (typically qualitative) in addition to deductive methods (typically

quantitative) in supply chain management. Mangan et al. (2004) and Singhal et al. (2008) similarly suggest that methodological triangulation, using quantitative and qualitative methodologies, can yield greater insights than if only a single research methodology is employed.

As Golicic et al. (2005) fittingly explain, balance in research can be achieved by "tacking back and forth between qualitative and quantitative approaches…An inductive approach is often needed to begin to understand and generate substantive theory about new and/or complex phenomena while a deductive approach is better for developing and then testing formal theory. Research studies should then progress through the circles (as shown in Figure 3-2), sometimes repeating the same circular path, sometimes crossing over to the other approach."



Source: Golicic et al. (2005)

Figure 3-2: The Balanced Approach Model

More generally, this has led to calls for a grounded theory approach to research (e.g. Corbin and Strauss, 1990), in which theory emerges from data obtained in the field rather than from a priori assumptions developed before the research began (Kaufmann

and Denk, 2011). In grounded theory, the inductive/deductive approach and the constant reference to the data helps to "ground" the theory (Mangan et al., 2004). Many researchers have observed that OM research lags practice and field-based empirical research can narrow this gap because it takes the researcher to the field for dialogue and observation (Swamidass, 1991). This discussion thus leads to the case study and survey studies approaches, which are common empirical research methods.

3.2. Case Study Method

A case study is an empirical inquiry of a contemporary phenomenon in its real-world context. As Yin (2013) and Johnston et al. (1999) emphasise, case study research is often seen as exploratory in nature, but it can also be explanatory. Although research protocols for doing inductive case studies are generally much better developed compared to the research protocols for doing deductive case studies, the latter type of studies can be applied in the confirmation (or falsification) of the appropriateness of a theory (Barratt et al., 2011).

Johnston et al. (1999) suggest that a confirmatory case study should have three elements, namely: hypotheses developed by theory; a research design that is logical and systematic; and findings that are independently evaluated. Yin (2013) also outlines four logical tests to judge the appropriateness of case-based research, namely in assessing (1) construct validity, (2) internal validity, (3) external validity, and (4) reliability. Of these, the primary concerns are construct validity (whether the measurements are reflective of the phenomena) and internal validity (whether the conjectured relationships actually exist).

One criticism of the case study approach is that it often involves a small-sample size (Johnston et al., 1999; Stuart et al., 2002). However, while survey research relies on statistical generalisation, case studies rely on analytical generalisation (Yin, 2013). In other words, the size of the sample is less important than the contextual data from case studies that are used to confirm or falsify a theory (Barratt et al., 2011). Hence, the selection of cases should be based on theoretical sampling, in which cases that differ as widely as possible from each other are chosen to fill theoretical niches, rather than based on random samples from representative populations (Stuart et al., 2002), as is the norm in the survey method.

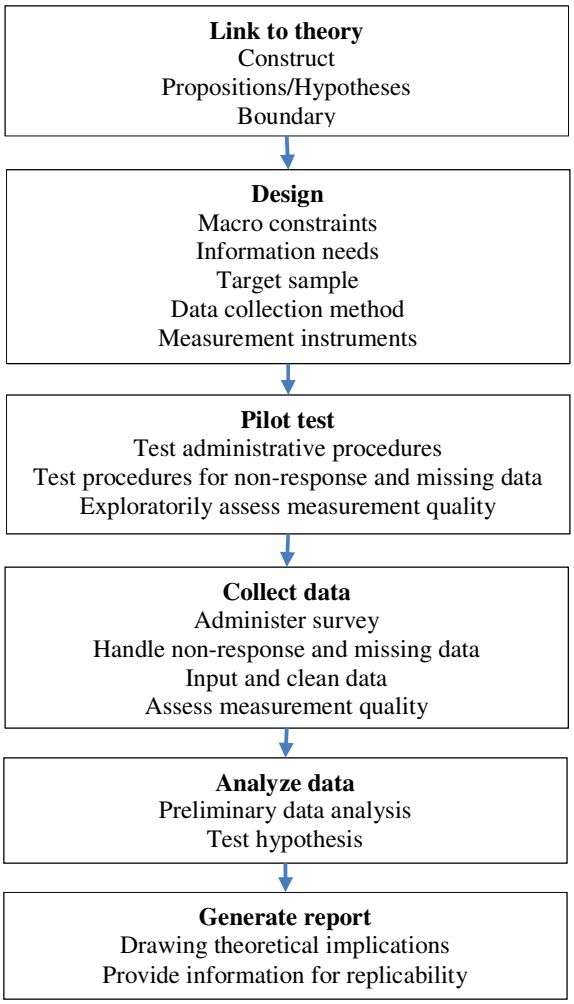
3.3. Survey Study Method

A survey generally involves the collection of information from individuals (through mailed/online questionnaires, telephone calls or personal interview) about themselves or about the units to which they belong, through which information about a large population could be obtained with a known level of accuracy (Forza, 2002).

The survey method has several advantages as a research tool. First, by using a survey, it is generally possible to conduct large-scale studies with multiple respondents that are representative of an even larger population. Second, the survey method allows for the collection of perceptual data to measure some constructs like leadership, which cannot be measured using secondary data (Singhal et al., 2008). On the other hand, the reliance on self-reported data in surveys can be seen as less objective than the use of secondary data, particularly with respect to performance data. In some situations, common method variance (i.e. spurious correlation between variables that is created by using the same method, in this case a survey, to measure each variable) can also result distort observed

relationships, thereby causing researchers to reach erroneous conclusions (Podsakoff et al., 2003; Craighead et al, 2011).

Much like the case study method, surveys can be either exploratory, confirmatory or descriptive in nature. Exploratory survey research usually occurs during the early stages of research, when the objective is to gain preliminary insight and provide the basis for more in-depth survey (Forza, 2002; Malhotra and Grover, 1998). Confirmatory (or theory testing or explanatory) survey research takes place when theoretical framework on a phenomenon has been defined via well-defined concepts, models or propositions. Survey data is then collected to test the adequacy of the concepts developed in relation to the phenomenon, hypothesised linkages, and the validity boundaries of the models. On the other hand, descriptive survey research is aimed at understanding the relevance of a certain phenomenon and describing the distribution of the phenomenon in a population. Of these type of surveys, confirmatory survey research is probably the most common and is the approach adopted in this thesis. Figure 3-3 shows the various steps in a well-designed theory-testing survey research process.

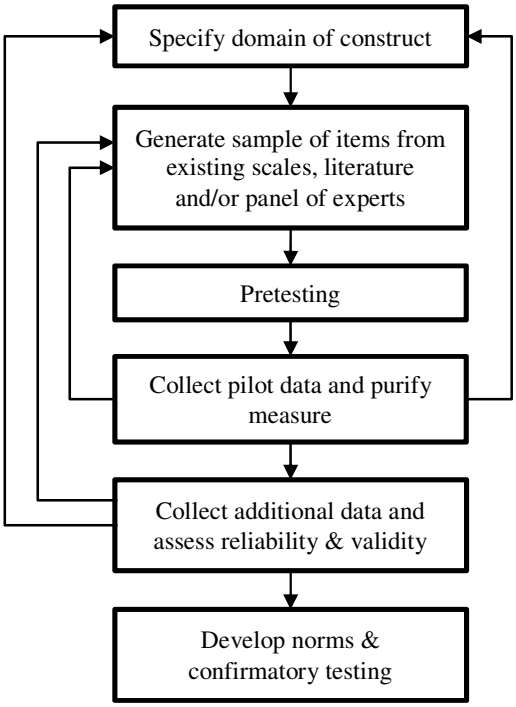


Source: Adapted from Forza (2002)

Figure 3-3: The Theory-Testing Survey Research Process

A key concern in survey design is the development of constructs, which are abstractions in the theoretical domain that express similar characteristics (Malhotra and Grover, 1998). A construct is "latent" or not directly measurable and therefore, researchers must provide an operational definition of it that is observable, i.e. via measurement items that are more informally known as survey questions. This in turns leads to a need for the assessment and assurance of measurement quality, which deals with the reliability and validity of measuring items for the constructs in a theoretical framework. Validity is

concerned with whether the right concept is measured, while reliability is concerned with stability and consistency in measurement (Forza, 2002). Lack of validity introduces systematic errors (bias), while lack of reliability introduces random errors, both of which can possibly lead to incorrect inferences and misleading conclusions (Forza, 2002). Figure 3-4 shows a framework for developing measurement scales, as provided by Malhotra and Grover (1998) and also adopted for this thesis.



Source: Malhotra and Grover (1998)

Figure 3-4: A Framework for Developing Scales

3.4. Analytical Concepts of Fit

While case studies and surveys are means of conducting empirical research, data and variables collected must still be appropriately analysed to link the phenomenon to the theory. Venkatraman (1989) suggests that there are six different forms of fit based on

the degree of precision of the functional form of fit and the number of variables considered in the fit equation (moderation, mediation, matching, gestalts, profile-deviation and co-variation). Of these, moderation, mediation and covariation are of particular relevance to this study and are summarised in Table 3-1.

Analytically, questions of "*how"* are typically approached using process or mediation analysis, whereas questions of "*when"* are most often answered through moderation analysis (Hayes, 2013). Mediation analysis seeks to establish the extent to which some putative causal variable, X, influences some outcome, Y, through one or more mediator variables. In contrast, a moderation analysis seeks to determine whether the size or sign of the effect of X on Y depends on one or more moderator variables (Hayes, 2013).

On the other hand, covariation is a pattern of internal consistency among a set of underlying theoretically related variables and is modelled as a factor analysis of a grouping of attributes from a set of observations (Venkatraman, 1989). This perspective requires logical consistency among the factors and an underlying logical link among the attributes. Venkatraman (1989) points out that covariation can be represented via a second-order factor model that is a parsimonious explanation of the covariation among the first-order factors, but even if the second-order factor model effectively explains the covariation among the first-order factors, the goodness of fit can never exceed that of the first-order factor model.

Table 3-1: Comparison of Moderation, Mediation and Covariation Concepts of Fit

Key Characteristics	Fit as Moderation	Fit as Mediation	Fit as Covariation
Underlying conceptualisation of fit	Interaction	Intervention	Internal consistency
Example of a verbalisation of a strategy proposition	"The interactive effects of strategy and managerial characteristics have implications for performance"	"Market share is a key intervening variable between strategy and performance"	"The degree of internal consistency in resource allocation has significant effect on performance"
Number of variables in the specialisation of fit	Two	Two to multiple	Four (for model identification purposes) to multiple
Analytical schemes for testing fit	Analysis of variance Moderated regression analysis Subgroup analysis	Path analysis	Second order factor analysis (confirmatory)
Measure of fit	Statistical derivation	Statistical derivation	Internal measure

Source: Adapted from Venkatraman (1989)

The concepts of moderation and mediation are closely linked to the notion of context-based research for OM best practices. Sousa and Voss (2008) note that as OM best practices become mature, research interest shifts from the justification of the value of those practices to the understanding of the contextual conditions under which they are effective. When research on emergent or promising practices are conducted, the impact these practices is often based on anecdotal case studies of ''excellent'' or ''world class'' firms, which tend to be large and operate in global, high-tech, and/or highly competitive and dynamic industries. These also tend to be the type of companies that make up the samples used in the practice–performance empirical studies, which raises doubts on the universal validity of these practices (Sousa and Voss, 2008).

Sousa and Voss (2008) further suggest that one reason practitioners often report problems in implementing best practices is that these difficulties result from a mismatch between the proposed form of best practice and the particular organisational context. Correspondingly, there is a need to examine the contingency variables, which can be

grouped into four broad categories: national context and culture, firm size, strategic context, and other organisational context variables (Sousa and Voss, 2008).

3.5. Implications on Methodology

3.5.1. Research approach

Among S&OP papers academic published in journals, the case study and survey methods are the most common, while practitioner-based papers tend to be conceptual in nature (Kristensen and Jonsson, 2018). Many researchers (e.g. Grimson and Pyke, 2007; Thomé et al., 2012a & 2012b; Tuomikangas and Kaipia, 2014) have called for more empirical studies in S&OP, particularly case studies and surveys. Given the practitioner origin and process-based nature of S&OP, case studies would be useful in providing a cross-sectional view of focal companies and presenting evidence of how and why S&OP brings about greater coordination within a firm. On the other hand, it is also apparent from the literature review that the linkages between S&OP practice and theory are relatively under-developed (Ambrose and Rutherford, 2016). While some survey-based S&OP studies (e.g. Thomé et al., 2012a; Ambrose and Rutherford, 2016) have been conducted, structural models to link S&OP constructs to performance outputs are generally lacking in the S&OP literature. Consequently, there is a need to utilise a combination of qualitative (case study) and quantitative (survey) elements, if the research questions in this thesis are to be fully addressed.

In line with the balanced approach of Figure 3-2, this thesis has adopted the combination of a preliminary survey, a case study and a large-scale survey (with the latter analysed in two phases). Furthermore, the methods as applied in this thesis do not follow the

inductive, deductive and abductive approaches in any strict order, nor in a mutually exclusive manner, but rather are more akin to the circular paths as shown in Figure 3-1. The sequence of the methods adopted is explained as follows.

Preliminary survey

At the initial exploratory stage of this research, the preliminary survey gathers important preliminary information and is intended to provide insights on S&OP as practiced generally in the industry, explore potential research themes and identify the basis for measurement, but without necessarily making any assumptions on the effectiveness or presence of coordinating mechanisms of S&OP.

Case study

In the next phase, a case study is designed with two case companies that have adopted S&OP but in different industries and with different supply chain priorities. During the first stage of the case study, the research strategy is still largely inductive in that the key features of the S&OP programmes studied (new product introduction and supplier integration) were the result of the prior decisions made by the case companies, rather than being instigated though the course of this research. With evidence of tangible improvements in performance from S&OP at the companies studied, this then helps set the stage to develop stronger measures for a subsequent survey (Singhal et al., 2008).

Survey

In the next phase of the study, the research strategy switches to a large-scale survey method. Initially, existing theory is relied upon for the inductive development of the theoretical framework for S&OP coordination mechanisms and the corresponding set of research hypotheses in the survey. Data collected from the survey would then help

confirm or falsify the theoretical framework via deduction. Finally, with the results derived deductively, the existing literature is revisited for further interpretation of results through an abductive "theory matching" process to identify the most likely explanation for the empirical observations. With the survey results from Phase 2 of this thesis, it would then be possible for further inductive reasoning to refine the theoretical model and repeat the deductive-abductive loop to obtain further insights in Phase 3 of this study.

3.5.2. Case selection and survey sampling

As the above overview of the case study and survey methods suggests, it is imperative that the subjects or respondents selected for this thesis are appropriate and fit for purpose under each method.

For the case study in Phase 1 of this thesis, the two subject companies selected via the theoretical sampling process have experience as adopters of full cycles of S&OP and are yet significantly different in terms of industry, demand patterns faced, supply chain priorities and S&OP maturity, such that a cross-case analysis can be carried out meaningfully. Another criterion necessary for selecting case subjects in this thesis is that both target companies must have reliable data collection and archival abilities, which would allow an analysis of how their supply chain performances have evolved over time.

In the survey in Phases 2 and 3 of this study, the inputs and experiences of a large number of S&OP practitioners are required to derive a credible survey sample. While the nature of surveys involves random sampling, diligence has been adopted in this study to only perform random sampling on a *qualified* pool of prospective respondents

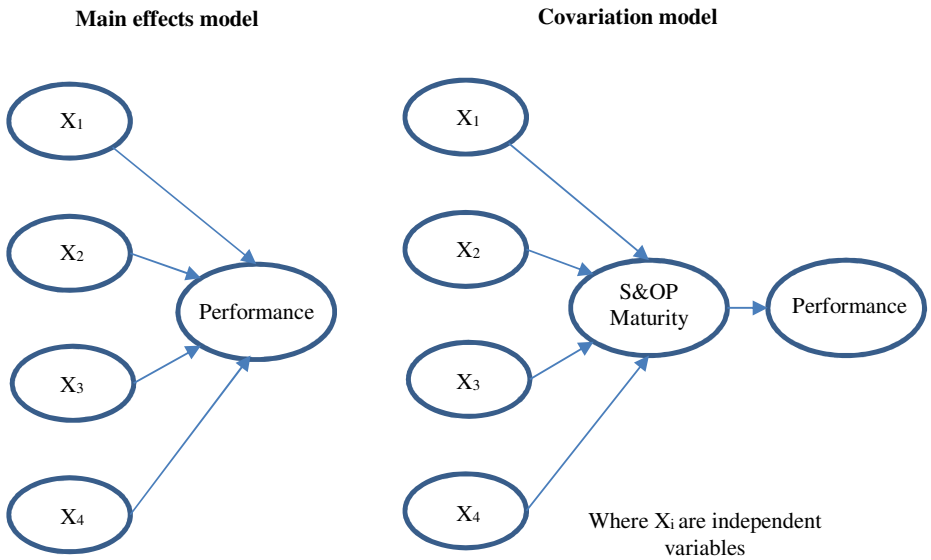
who are verifiably S&OP practitioners, rather than merely interested observers of S&OP practices. More details on this process can found in Section 5.4.2.

3.5.3. Measurement scale development

In any survey, the quality of the responses received will be limited by the accuracy of the measurement items (Malhotra and Grover, 1998; Forza, 2002). Hence, the process for the development of the measurement scales for the survey in Phases 2 and 3 of this thesis follows the framework as suggested by Malhotra and Grover (1998). For example, the definitions of the individual measurement items are closely based on relevant keywords derived from the literature, so that the items are representative of the underlying construct. Furthermore, the measurement items are pre-tested with a smaller pool of trial respondents to ensure that the items are unambiguous before the actual survey is launched. After the survey responses have been collected, checks for validity and reliability are also conducted, which are elaborated in in Sections 5.4.3 and 5.4.4.

3.5.4. Structural model formulation

At first glance, the notion of S&OP maturity (as discussed in 2.3.2) appears to lend itself well to the concept of fit as covariation, i.e. S&OP maturity may be represented as a latent second-order factor that models the covariation among S&OP coordination mechanisms, as shown in Figure 3-5.



Source: Adapted from Venkatraman (1989)

Figure 3-5: Main Effects Model versus Co-Variation Model with S&OP Maturity

However, modelling a second-order factor with coalignment has two inherent challenges. First, from a statistical perspective, as highlighted above in Section 3.4, a structural model with a second-order factor would lead to a goodness of fit that is inferior to a main effects model with only first-order factors (Venkatraman, 1989). Secondly, from a logical perspective, coalignment requires consistency and link among the primary constructs, which in this case might be verbalised as "the degree of internal consistency in S&OP coordination mechanisms manifests as S&OP maturity, which in turn has a significant effect on performance". However, such a logical link is problematic, as S&OP maturity (as a second-order construct) is arguably symptomatic of the state of coordinating mechanisms in an S&OP programme but is not the underlying cause of S&OP effectiveness. Moreover, it is not clear whether a firm that falls short in one aspect of S&OP maturity will experience shortfalls in performance,

regardless of how well it rates in the other aspects. Hence, in this study, the main effects model of Figure 3-5 would be more appropriate for the structural modelling phases of this thesis.

Separately, as the literature review reveals, numerous variables such as firm size and various product attributes have been considered in many previous S&OP survey-based studies. Yet, it is not always clear whether these variables are confounding, causal or contingency factors, which can be tested using moderation and mediation techniques (Venkatraman, 1989; Bauman et al., 2002) that have been incorporated as part of this research in Phase 2 and Phase 3.

3.6. Conceptual Research Framework

The synthesis of the literature and methodological perspectives hence leads to the conceptual research framework as shown in Figure 3-6, which forms the basis for the three papers in the next three chapters of this thesis.

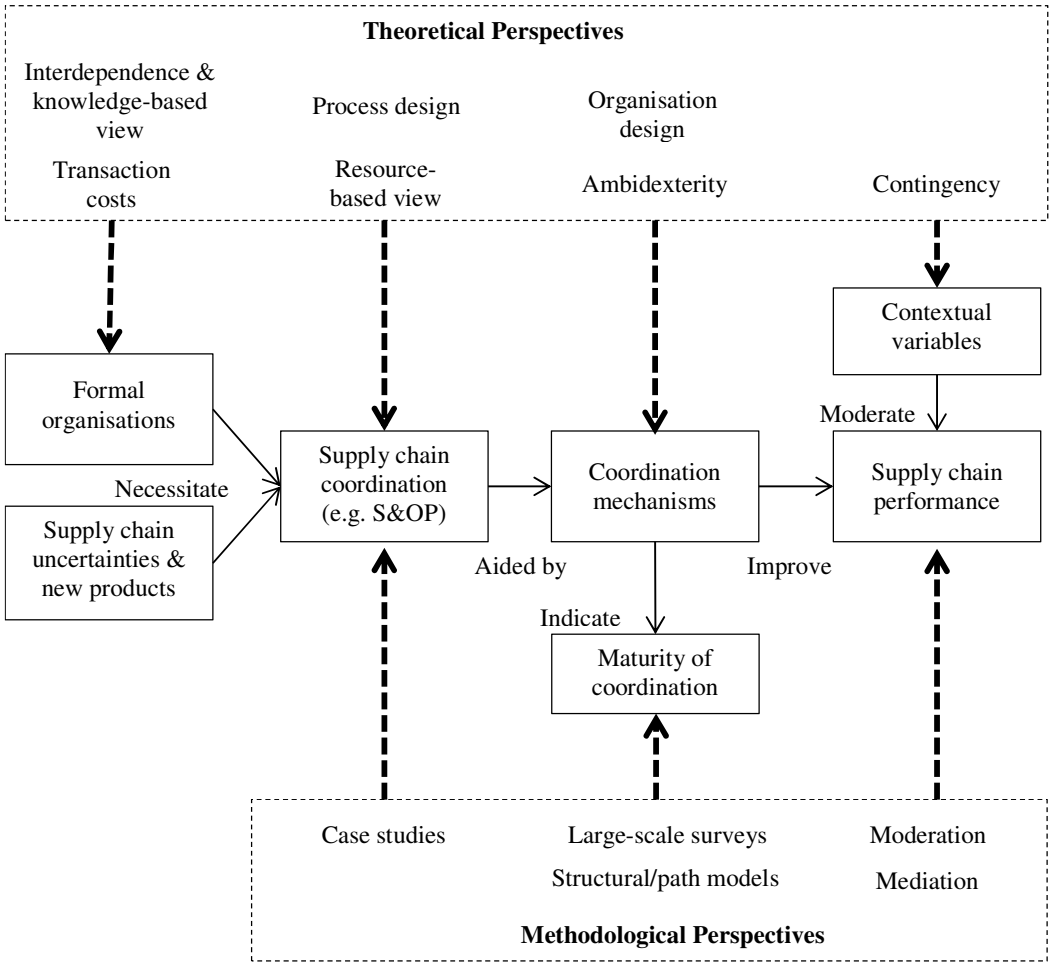


Figure 3-6: Conceptual Research Framework

While several theories from Operations Management and Organisational Science have been identified in Chapter 2 as being relevant to this thesis, some of these theories (e.g. contingency theory and coordination mechanisms in organisational theory) are relied upon to conduct theory-driven empirical research i.e. to provide input into the design the case and survey studies, while the role of other theories (e.g. ambidexterity) is mainly in their use in abductively explaining and interpreting the findings.

Chapter 4 – New Product Introduction and Supplier Integration in Sales and Operations Planning: Evidence from the Asia Pacific Region

This chapter is adapted from a manuscript submitted to and published in the International Journal of Physical Logistics and Distribution (IJDLM). It is cited in Chapters 5 and 6 as "Goh and Eldridge (2015)". This manuscript is authored by Shao Hung Goh and Stephen Eldridge. Both authors contributed to the study design and manuscript preparation. The primary analysis was conducted by the first author, based upon the data provided by two company informants. Adjustments have been made to the original manuscript (such as in the numbering of sections, figures and tables) to improve the coherence with other parts of this thesis.

Abstract

This paper investigates the implementation and performance benefits of Sales and Operations Planning (S&OP) within organisations in Asia Pacific. 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 programme. Supply chain performance data was collected and analysed in the context of an S&OP maturity framework. 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. 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 generalised picture of S&OP implementations in the Asia Pacific region to emerge. 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. 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.

Keywords: Sales and operations planning, new production introduction, supplier integration

4.1. 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 Kilpala, 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 organisations have had limited success owing to a variety of factors such as: a lack of process ownership; misalignment between stakeholders; functional silos in the organisation; flawed performance management metrics; too many stock-keeping units; and forecasting errors (Iyangar and Gupta, 2013; Slone et al., 2013; Wagner et al., 2014).

Therefore, for organisations to realise 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 organisations 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 4.3. The case findings are presented in Section 4.4 with further cross-case analysis and discussion in Section 4.5. The conclusions and recommendations for further research are presented in Section 4.6.

4.2. 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. (2012a) 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 categorisation of previous research on S&OP in the literature. As Thomé et al. (2012a) 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., 2012), 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 fulfilment 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, 2002a). 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 commercialisation 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 characterised 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., 2008). 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) present 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, synchronised end-to-end supply chain. Wang et al. (2012) 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, organisation 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 centralising 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 (Table 4-1) has been chosen as the main reference as it is the seminal academic paper in the literature on S&OP maturity models.

Table 4-1: 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
Organisation	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	Centralised 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 summarised in Figure 4-1).

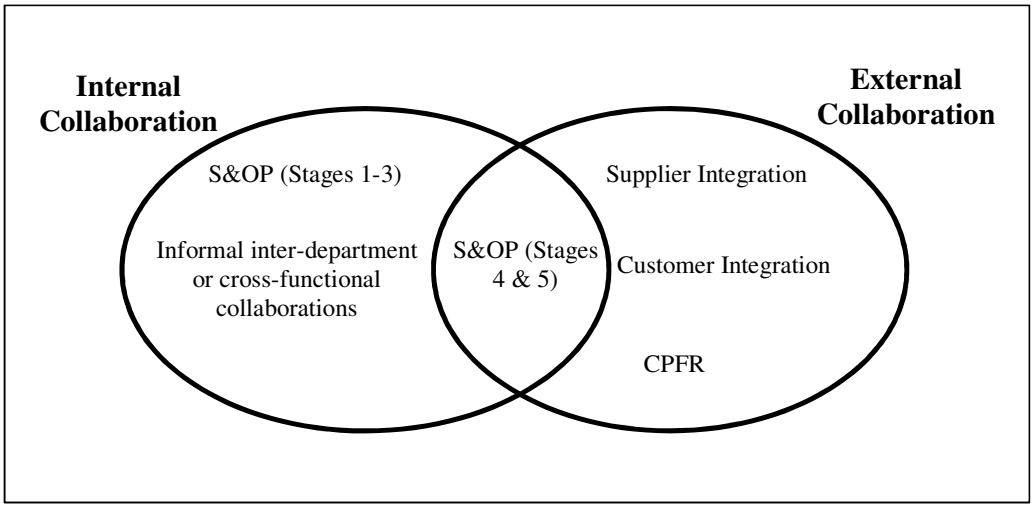


Figure 4-1: S&OP within the Supply Chain Collaboration Context

As Figure 4-1 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. (2014a) 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. (2014a) 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 analysed the actual impact of S&OP on the performance of the firm (Thomé et al., 2012a). One of these is that of Nakano (2009),

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. (2012) 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 modelling, rather than actual implementation outcomes of advanced S&OP at the target company. It also did not compare the theoretical optimised 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 "emphasise on internal control primarily to reduce costs" while US firms emphasise "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 organisations 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 organisations being studied.

4.3. Research Methodology

4.3.1. Research objectives

The research objectives can be summarised 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

4.3.2. Method selection

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

There have 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. (2014a). 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, 2009), 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 Figure 4-2 and Figure 4-3. 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.

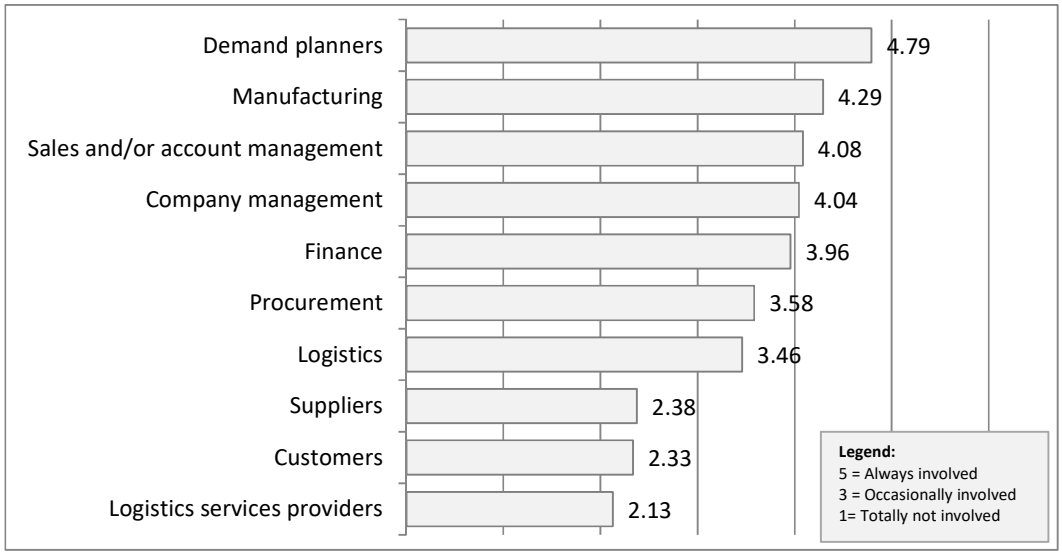


Figure 4-2: Participants' Level of Involvement in S&OP among Asia-Pacific Companies (N=25)

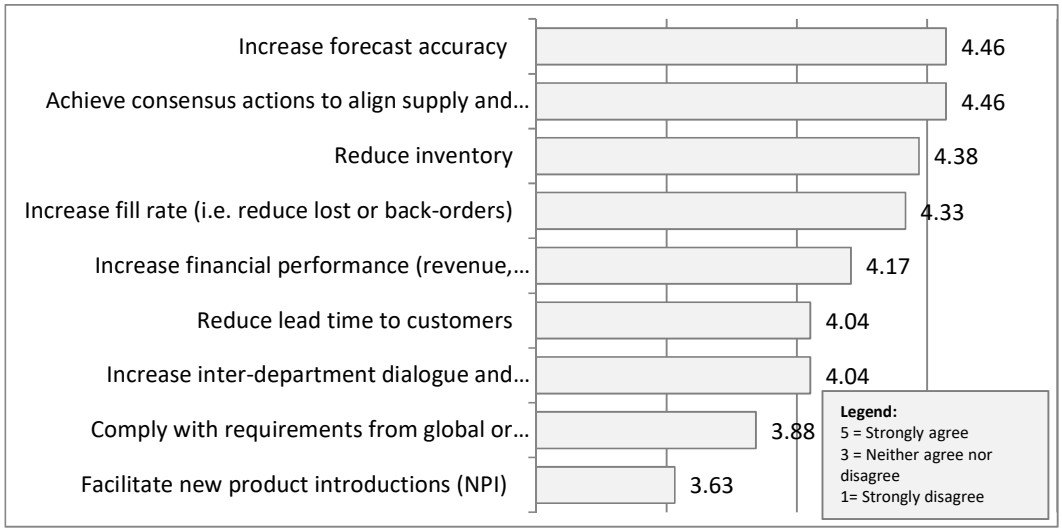


Figure 4-3: Motivations of Implementing S&OP among Asia-Pacific Companies (N=25)

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 generalise 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., 2014a). Furthermore, the use of two cases also enables insights into the relative maturity of the S&OP processes at both target companies.

4.3.3. 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 centre 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 centre industry. Company B's customers are mainly enterprise-level IT organisations, 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 centre (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 organisational 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 4-2 summarises the two companies' product profiles and fulfilment strategies.

Table 4-2: Profile of Companies in Case Studies

Supply Chain and Selection Criteria	**Company A**	**Company B**
Product type	Fire protection equipment	Data centre 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
Fulfilment 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 centre 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 minimised 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 programme.

4.3.4. 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 4-3 summarises the list of information and data that were required to address the research objectives.

Table 4-3: 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 centre, 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 centre 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 centre

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 normalisation of data was performed (e.g. normalising 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.

4.4. Case Study Findings

4.4.1. Case 1 – Internal S&OP as applied to new product introduction

Figure 4-4 shows the typical flow of products from Company A's plants and suppliers to customers across South East Asia.

Figure 4-4: 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 4-5 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.

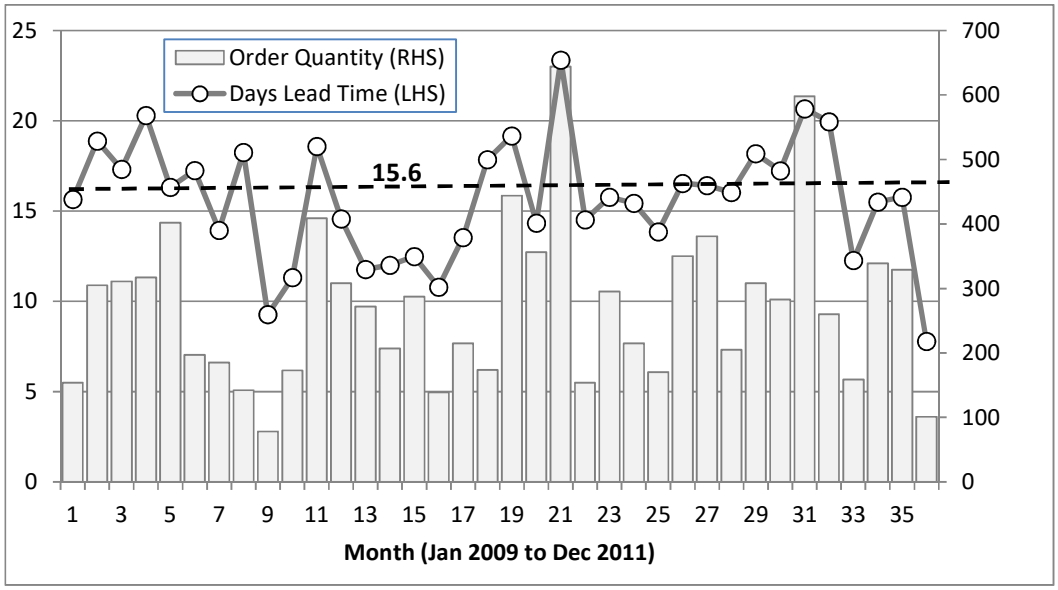


Figure 4-5: Order Quantities and Order Lead Times for a Mature SKU (S&OP not Implemented)

For new SKUs (Figure 4-6), 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).

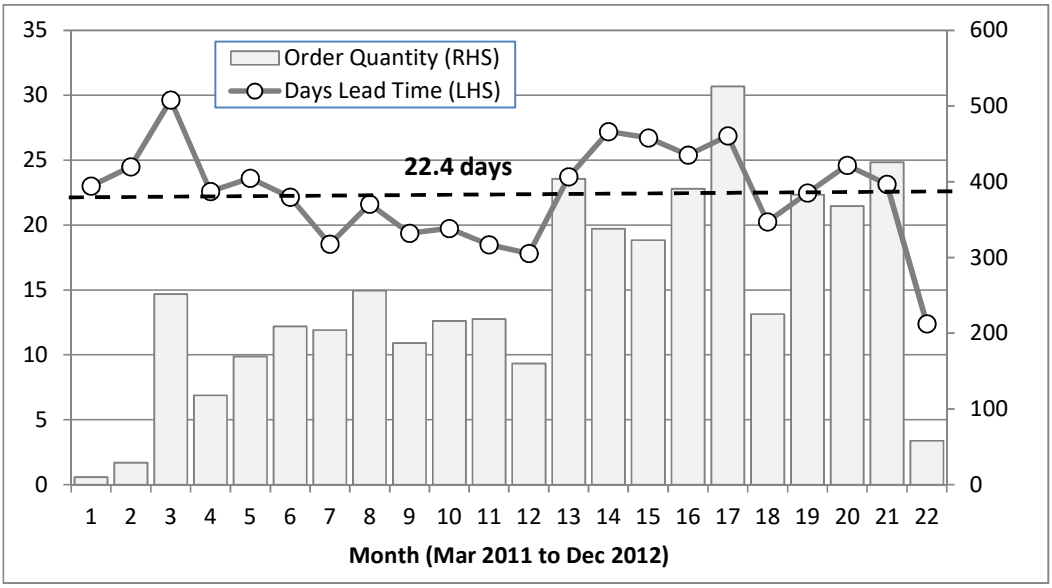


Figure 4-6: Order Quantities and Order Lead Times for a New SKU (S&OP not Implemented)

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 4-7) and the new process (Figure 4-8):

- 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 organisation.

- 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.

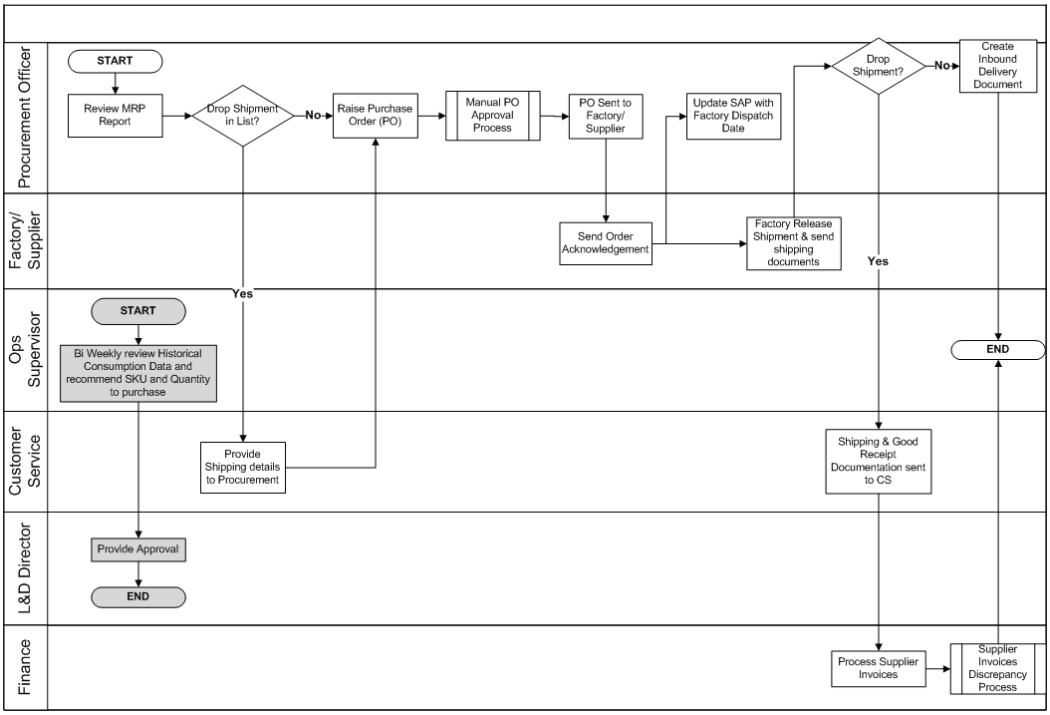


Figure 4-7: Existing Process as Practised by Company A

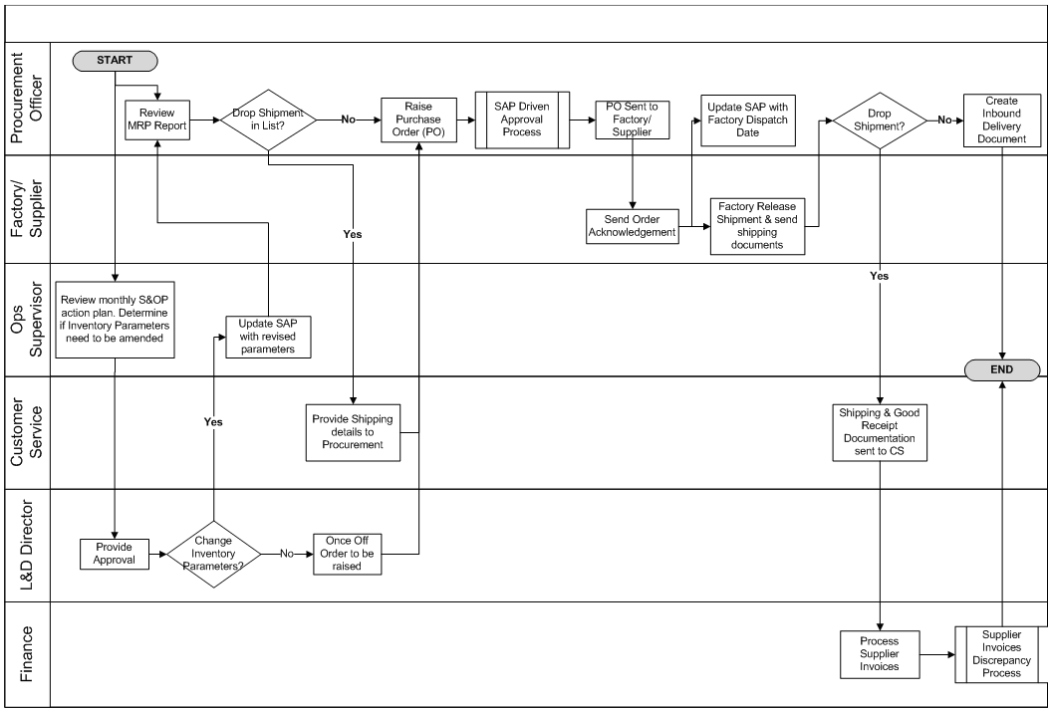


Figure 4-8: New Process with S&OP as Practised by Company A

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 4-9). 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 4-6). 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.

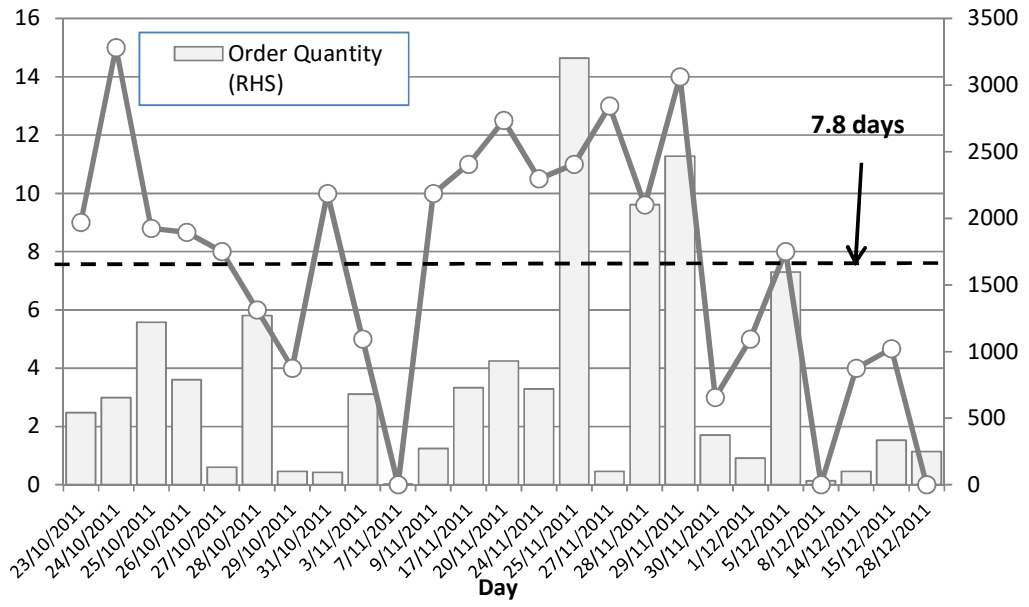


Figure 4-9: Order Quantity and Order Lead Times for a New SKU (S&OP Implemented)

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.

4.4.2. Case 2 - S&OP with supplier integration

In 2010, Company B adopted a basic form of S&OP within its organisation. 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 centre 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 finalised 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 4-10 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 centre (RDC).

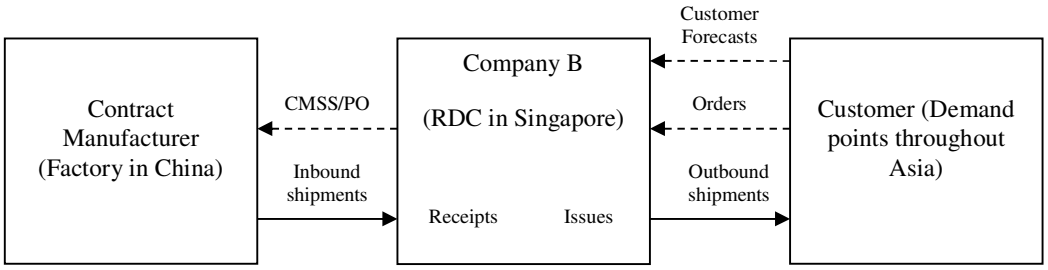


Figure 4-10: Simplified Supply Chain for a Typical Company B OEM Product

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 analysed 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 fulfil its customers' demand.

Figure 4-11 shows the 5 main stages of Company B's new process with its contract manufacturer.

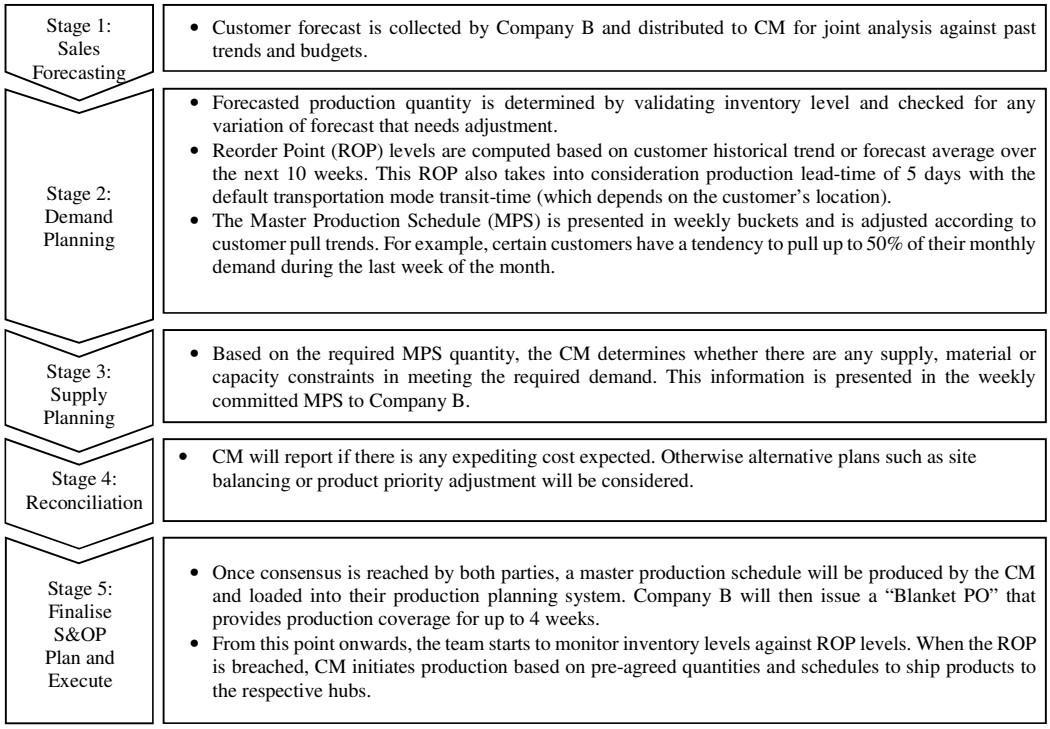


Figure 4-11: Company B's New S&OP Process with its Contract Manufacturer

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 4-12, 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).

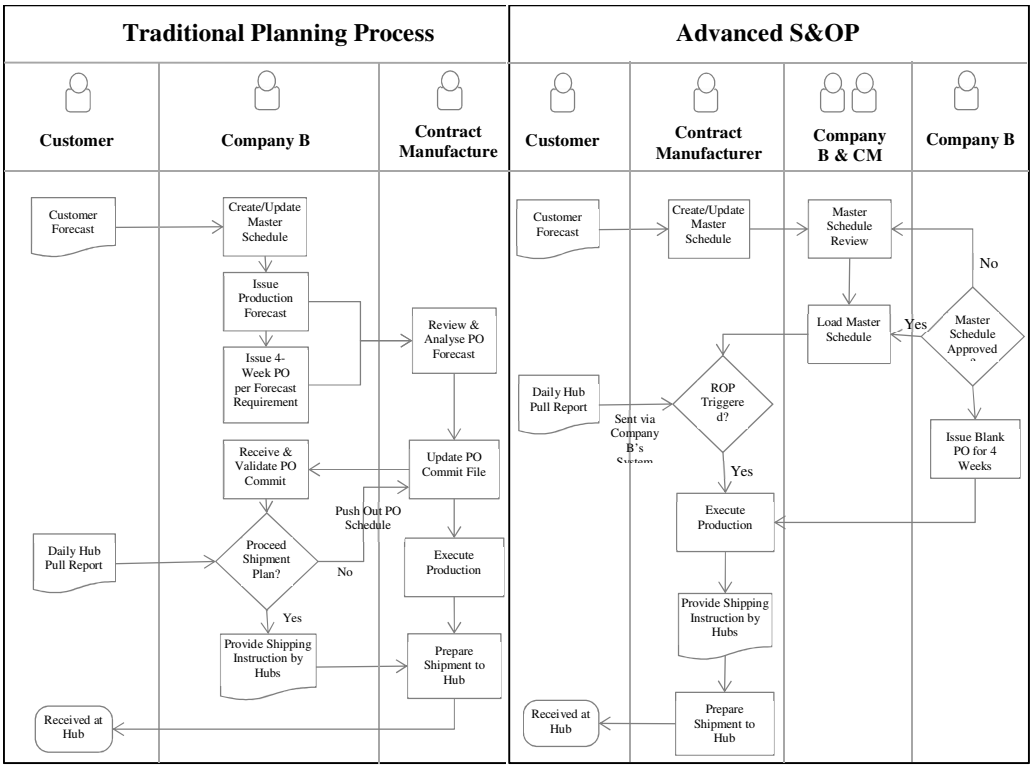


Figure 4-12: Flowcharts for Traditional Planning versus Advanced S&OP

Table 4-4 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 4-4: 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 fulfilment 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 centre 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.

Inventory Level

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

$$\textit{Normalised Weekly Inventory} = \frac{\textit{Average Weekly Inventory}}{\textit{Average Past 4 Weeks of Sales}} \qquad (1)$$

A low level of normalised inventory typically indicates superior performance in inventory control. The chart below (Figure 4-13) is the plot of an index of normalised inventory, before and after the Advanced S&OP process was introduced.

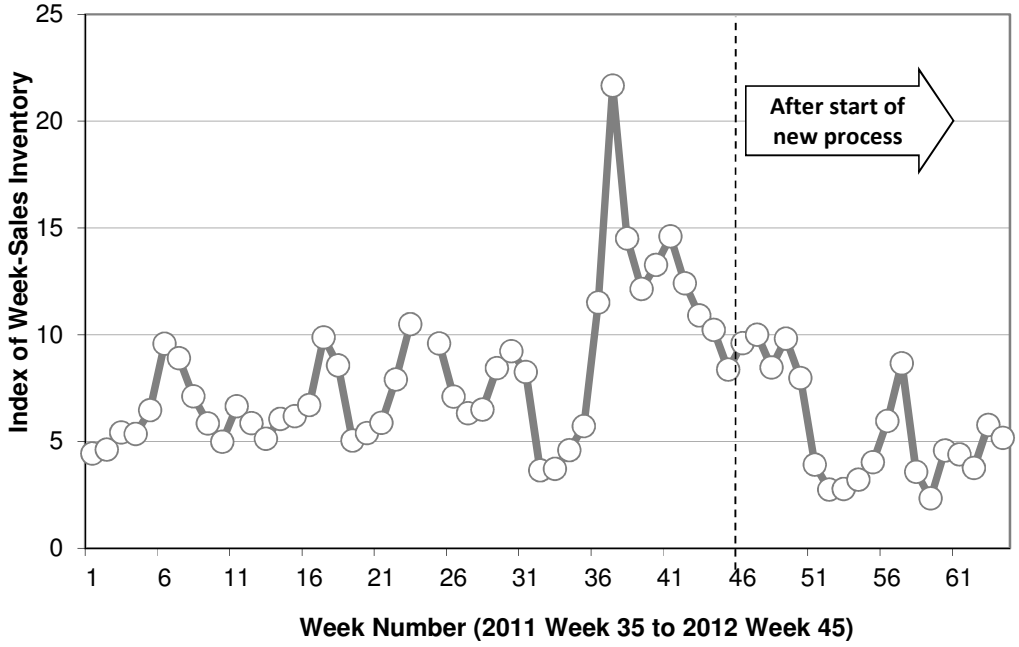


Figure 4-13: Normalised Inventory Before and After Advanced S&OP

(Note: The normalised 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%).

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 centre (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 analysing 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:

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

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 4-14, for the period before and after the Advanced S&OP process was introduced.

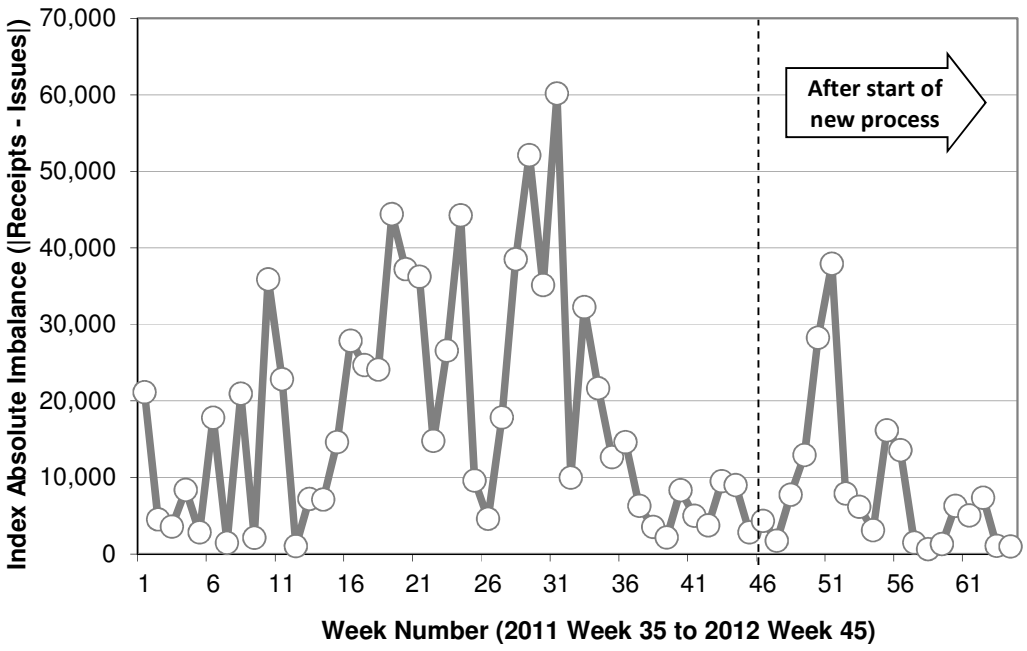


Figure 4-14: Balance between Inbound and Outbound Shipments

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 4-14, 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.

4.5. Discussion of Findings

As summarised in Table 4-5 and Table 4-6, 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 4-5: 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 4-6: 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 et al., 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; Iyangar 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 programmes 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 Iyangar and Gupta (2013).

4.5.1. 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 4-15 summarises 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.

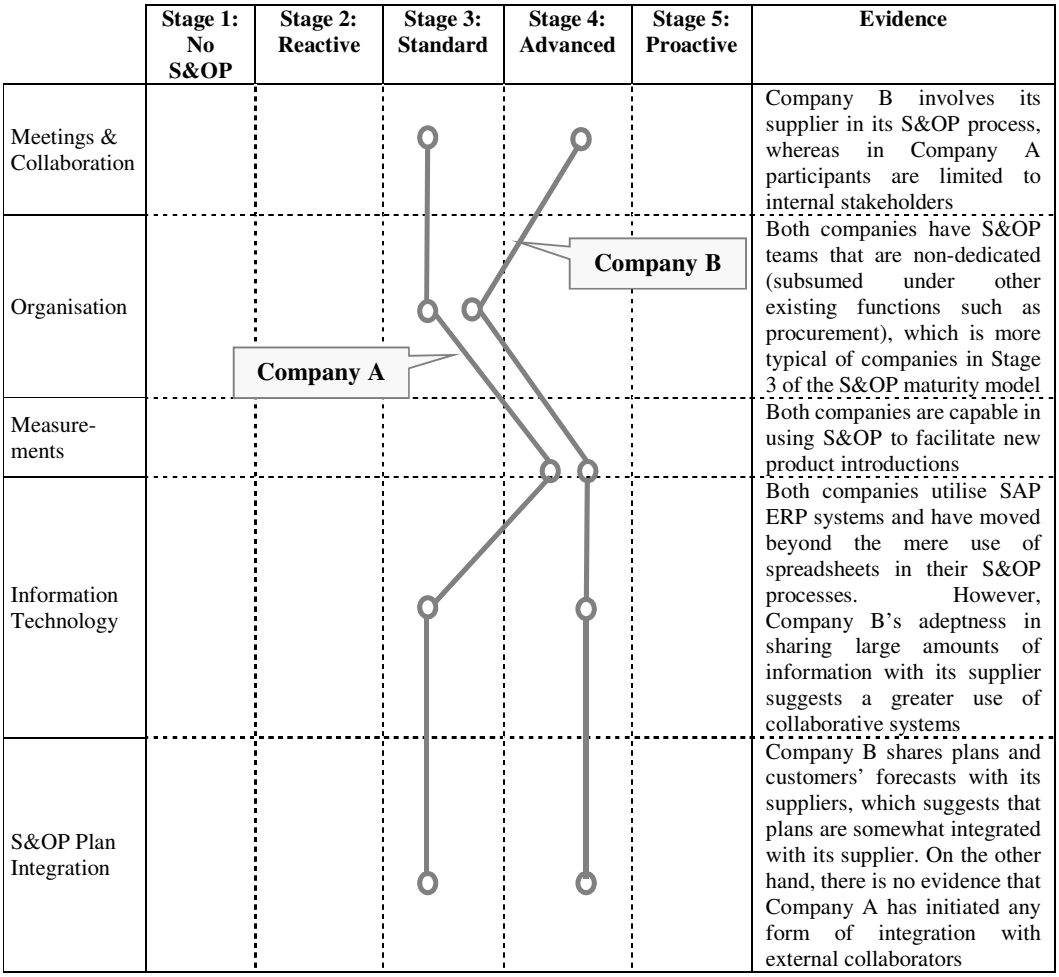


Figure 4-15: S&OP Maturity Assessment of the Two Case Companies

Company A is almost a typical company that practises 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 provided 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 "organisation" 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 "organisation" 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 stabilise 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).

4.5.2. 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 organisational objectives that are aligned and by gradually "levelling 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 standardised 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 4-2 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.

4.5.3. 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 emphasised 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 organisations 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 organisation 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.

4.6. 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 standardised tool but rather should be tailored towards the specific objectives of organisations, 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 organisation 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., 2012a). As Tuomikangas and Kaipia (2014) pointed out, academic authors have emphasised the need for empirical research to complement existing modelling 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. (2014a)'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 analysing 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.

Chapter 5 – Sales & Operations Planning: The Effect of Coordination Mechanisms on Supply Chain Performance

This chapter is adapted from a manuscript that is currently under review by an academic journal and it is cited in Chapter 6 as "Goh and Eldridge (2018)". An early version of this research was presented at the 23rd EurOMA Conference in 2016. This manuscript is authored by Shao Hung Goh and Stephen Eldridge. Both authors contributed to the study design and manuscript preparation. Data collection and primary analysis were conducted by the first author. Adjustments have been made to the original manuscript (such as in the numbering of sections, figures and tables) to improve the coherence with other parts of this thesis.

Abstract

Sales and Operations Planning (S&OP) is a means of facilitating cross-functional coordination, such as across the marketing-operations interface, but adopters of S&OP have not all benefited from S&OP to the same extent. This paper investigates the effect of S&OP on supply chain performance using the perspective of coordination and contingency theories. A structural equation model was developed in which six S&OP coordination mechanisms were hypothesised to contribute to improved supply chain performance. The model was tested using a global survey of 568 experienced S&OP practitioners. Our results indicate that Strategic Alignment and Information

Acquisition/Processing are the mechanisms that most significantly enable superior S&OP outcomes. However, we find that a highly formalised S&OP Procedure inhibits supply chain performance. Furthermore, using a contingency theory perspective, increasing firm size and increasing experience in S&OP amplify the negative effect of a standardised S&OP Procedure upon supply chain performance. Our results suggest that organisational bricolage may be a coordinating mechanism of effective S&OP programmes and that managers should empower ambidextrous S&OP teams to maintain balance using self-governing event-driven processes. This paper makes a novel contribution to the S&OP literature by providing evidence of a theoretical construct (organisational bricolage), which may trigger a re-evaluation of the efficacy of prescriptive S&OP procedures that have been advocated by researchers and practitioners.

Keywords: S&OP; Supply chain management; Marketing-operations interface; Coordination; Contingency; Structural equation modelling

5.1. Introduction

Sales and Operations Planning (S&OP) is a 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 of resources and most profitable supply chain mix (Muzumdar and Fontanella, 2006). S&OP can also be described as a means for internal coordination in which a cross-functional team reaches consensus on sales forecasts, capacity and/or production plans (Lapide, 2004a). APICS (www.apics.org) formally defines Sales and Operations Planning (S&OP) as a process that "brings

together all the plans for the business (sales, marketing, development, manufacturing, sourcing, and financial) into one integrated set of plans." (Pittman and Atwater, 2016). The reported benefits of S&OP are numerous and include: higher customer satisfaction; lower and more balanced inventory; lower lead times; more stable production rates; more cooperation across the entire operation; better forecasting; more efficient decision making; and a greater focus on the long-term horizon (Thomé et al., 2012a; Tuomikangas and Kaipia, 2014; Noroozi and Wikner, 2017).

However, some companies struggle to realise these benefits (Lapide, 2005; Iyangar and Gupta, 2013; Swaim et al., 2016) and researchers have proposed classifications of S&OP implementation maturity in order to identify appropriate pathways for S&OP performance improvement (e.g. Lapide, 2005; Grimson and Pyke, 2007; Wagner et al., 2014). For example, Grimson and Pyke (2007)'s maturity framework assesses five aspects of S&OP implementation drawn from the firm's business processes (meeting and collaboration, organisation and performance measurements) and its information processes (information technology and S&OP plan integration). Subsequently, researchers have refined these aspects into "S&OP coordinating mechanisms" (e.g. Thomé et al., 2014a & 2014b; Tuomikangas and Kaipia, 2014). The presence of these S&OP coordinating mechanisms, individually or collectively, should be able to explain the inconsistency in firms' abilities to realise the expected benefits from S&OP implementation but this remains to be tested. Furthermore, some coordination mechanisms may be more influential in realising these benefits depending on a firm's business context.

Drawing on insights from coordination theory and contingency theory, our study examines empirically the link between these S&OP coordinating mechanisms and supply chain performance using data obtained from experienced S&OP practitioners.

Our aim is to understand the relative strengths of each mechanism and then explore how an individual firm's context may affect such relationships.

Initially, we provide an overview of the theories of coordination and contingency, in relation to the marketing-operations interface and S&OP implementation. We then develop hypotheses for use in a structural model for coordination mechanisms of S&OP and describe the approach adopted to test our hypotheses. We present the results of our analysis and then discuss their implications for researchers and practitioners.

5.2. Theoretical Background and Literature Review

S&OP is a means of coordination between functions and, to a lesser extent, between firms. As such, we begin by providing an overview of the development of coordination theory and coordination mechanisms in organisation science, and their roles in coordinating the marketing-operations interface.

5.2.1. Coordination and the marketing-operations interface

Coordination can be viewed as the resolution of intraorganisational goal conflict (Lawrence and Lorsch, 1967a) and an organisation can achieve this by managing dependencies between activities (Malone and Crowston, 1994). Typically, organisations create specialist functions to carry out these activities when the organisational task is complex (Galbraith, 1974; Grant, 1996; Heath and Staudenmayer, 2000). This increases the productivity or effectiveness of these individual functions but the specialists may focus more on partitioning the task than they do on integrating it, or they neglect the interrelationships and interactions among components (Heath and

Staudenmayer, 2000). Hence, the importance of coordination increases as organisations become reliant on interdisciplinary teams of specialists (Grant, 1996; Faraj and Xiao, 2006). Similarly, the need for coordination may also arise out of pooled interdependence where the activities of a firm are linked by the competing use of the same pool of resources (Thompson, 1967). In these contexts, coordination becomes the "input regulation and interaction articulation to realise a collective performance" (Faraj and Xiao, 2006) with coordination mechanisms providing the means for input regulation and interaction articulation. For example, Mintzberg (1979) identifies five coordinating mechanisms that may explain the fundamental ways in which organisations coordinate their work: mutual adjustment, direct supervision, standardisation of work processes, standardisation of work outputs, and standardisation of worker skills.

The importance of linking strategies that span across the marketing-operations interface and the impact on firm performance have been dealt with extensively in the academic literature (e.g. Karmarkar, 1996; Tang, 2010). Conflict between marketing and operations may arise when the operation's ability to supply does not meet the marketing's view of demand and as such a coordinated plan is usually developed through an iterative negotiation process among different functional groups (Tang, 2010). Interactions between functions would help make joint decisions on parameters such as lead time, quality, volume variation and product mix (Karmarkar, 1996). Sawhney and Piper (2002)'s research suggests that an effective marketing-operations interface can enable a firm to reduce defects, costs and late deliveries. Yet, while there have been significant advances in academic research on the marketing-operations interface, many of these models do not reveal much about the extent that internal

coordination mechanisms can be leveraged upon by managers to achieve better outcomes in various cross-functional settings.

5.2.2. S&OP as a form of coordination and the link to performance

Industry practitioners conceived S&OP as a practical (and even prescriptive) means of coordination not just across the marketing-operations divide but also more broadly across other functional groups such as top-management, finance and procurement (Grimson and Pyke, 2007). However, the empirical evidence linking S&OP, and its associated coordinating mechanisms, with improved firm performance is relatively limited. Nakano (2009) investigated 22 Japanese companies and found that S&OP has positive effects on logistics and production performance. Goh and Eldridge (2015) [i.e. Chapter 4 of this thesis] described the use of S&OP in two separate cases in the Asia Pacific region featuring new product introduction and supplier integration and found evidence of improved supply chain performance in both cases. Yet, it is difficult to generalise these results to other regions and other supply chain situations.

Researchers have conducted survey-based studies of the links between S&OP mechanisms and firm performance to attempt to remedy this concern. For example, Thomé et al. (2014a) found that internal S&OP practices have a moderate-to-large, positive effect on manufacturing performance, though their sample included only manufacturers who did not necessarily adopt formal S&OP. Ambrose and Rutherford (2016) studied a relatively small sample of respondents (144) and report that internal team factors (social cohesion and decision-making autonomy) and contextual influencers (information quality, procedural quality, and team-based rewards/incentives) drive collaboration, which in turn drives S&OP effectiveness (and

implicitly performance). Swaim et al. (2016) conducted a survey of 178 North American S&OP practitioners on the antecedents of S&OP. Drawing on agency theory and stewardship theory, they conclude that organisational integration positively influences a standardised S&OP process. In addition, both the S&OP process and prioritisation lead to stronger organisational S&OP engagement, which in turns leads to better S&OP effectiveness and performance outcomes. However, this study does not consider equivalent models for causality. For example, a standardised S&OP process could arguably have led to stronger organisational engagement as much as stronger organisational engagement could have led to a standardised S&OP process. In summary, S&OP exhibits the features of coordination, though the empirical evidence of a link between it and improved firm performance is less convincing.

5.2.3. S&OP maturity, organisational integration and ambidexterity

The S&OP literature has seen the rise in popularity of maturity models (e.g. Lapide, 2005; Grimson and Pyke, 2007; Wagner et al., 2014) that describe S&OP as highly process-based, but how the processes within S&OP work is not well-elaborated upon by these models. For example, from an input–process–output perspective, S&OP maturity does not directly impact performance, but rather through certain coordinating mechanisms (Tuomikangas and Kaipia, 2014). S&OP maturity (as a second-order construct) is hence merely symptomatic of the state of coordinating mechanisms in an S&OP programme but is not the underlying cause of S&OP effectiveness. Moreover, it is not clear whether a firm that falls short in one aspect of S&OP maturity will experience shortfalls in performance, regardless of how well it rates in the other aspects. Yet, structural and path models that link S&OP coordinating mechanism with S&OP

outcomes are generally lacking to test the relationships asserted by conceptual studies or those by practitioners.

Another common thread that runs through S&OP maturity models is that the degree of organisational integration is generally viewed to be positively correlated with maturity. In other words, S&OP is often associated with integration, while differentiation is to be discouraged (Oliva and Watson, 2011). Differentiation and integration may appear to be fundamentally at odds, but yet differentiation can be associated with positive organisation traits (such as innovation and dynamism). Benner and Tushman (2003) observe that the influence of process management techniques on tightly-coordinated processes can drive efficiency and incremental changes, but also lead to organisational inertia in responding to more disruptive changes. Therefore, coordination may imply greater control and lower room for creativity, leading to a tension or even an inverse relationship between the degrees of differentiation and integration in a firm (Lawrence and Lorsch, 1967a; Raisch et al., 2009).

Ambidextrous organisations are those capable of implementing not just evolutionary (i.e. incremental) and also revolutionary change. Superior performance is expected from ambidextrous organisations that have cultures that have "simultaneously tight and loose" social controls (Tushman and O'Reilly, 1996). In particular, by encouraging individuals to make their own judgments as to how best divide their time between the conflicting demands for alignment and adaptability, organisations can simultaneously achieve alignment and adaptability (Gibson and Birkinshaw, 2004) via "contextual ambidexterity". Organisational ambidexterity is closely linked to the concept of bricolage, in which organisations engage in role shifting, reorganising routines and reordering in response to uncertain or surprising situations (Bechky and Okhuysen, 2011).

5.2.4. S&OP and contingency

In the context of contingency theory, "organisational units operating in differing environments develop different internal unit characteristics, and that the greater the internal differences, the greater the need for *coordination* between units" (Lawrence and Lorsch, 1967b). Given the wide variety of organisational settings, alternative coordination mechanisms may result in different outcomes (Crowston et al., 2006). Kristensen and Jonsson (2018)'s review of the S&OP literature suggests that S&OP design depends on industry, dynamic complexity, detail complexity and organisational characteristics. Therefore, S&OP implementation features in a variety of environments and organisational settings, which can be illustrated by:

- ***Product characteristics***. S&OP is used widely across a wide of industries with highly diverse product characteristics including: product variety, shelf life and frequency of product launch (Ivert et al., 2015; Dreyer et al., 2018). The phenomenon of SKU (stock-keeping units) proliferation also increases the complexity and risks in S&OP.
- ***Economic maturity***. Thomé et al. (2014a) propose that companies operating in fast-growing geographical markets could be expected to show greater performance improvements from S&OP, though their results suggest economic maturity (or GDP per capita) does not affect the effectiveness of S&OP on manufacturing performance.
- ***Regional differences***. Studies on S&OP practices tend to be region or country specific (e.g. Jonsson et al., 2007; Nakano, 2009; Goh and Eldridge, 2015; Pedroso et al., 2016; Swaim et al., 2016), which raises the question of whether

organisations in other geographies have different emphasis on individual S&OP coordination mechanisms.

- ***Industry sector***. Thomé et al. (2014a) and Kristensen and Jonsson (2018) suggest that S&OP practices and their impact on firm performance might differ according to the type of industry sector. However, past studies in S&OP generally do not investigate differences in S&OP performance across industries. Some are specific to industry sectors, such as retail (Harwell, 2006; Dreyer et al., 2018), telecommunications equipment (Hadaya and Cassivi, 2007) and food production (Ivert et al., 2015), while others have research subjects that span multiple industries (e.g. Jonsson et al., 2007, Nakano, 2009).
- ***Firm size***. A large firm might be associated with a correspondingly large amount of resources that can be devoted to internal coordination (Kristensen and Jonsson, 2018), although firm size was not a significant variable in the study of Thomé et al. (2014a).

Notably, Thomé et al. (2014b) found that operational performance is amplified by process complexity, such that the more complex the manufacturing processes, the larger the gains of S&OP. Ivert et al. (2015) analysed eight case studies in the food industry and found that environmental contingencies (demand/supply uncertainty, frequency of product launches, and production network complexity) have a particularly important impact on S&OP design. Kaipia et al. (2017) present two case studies and show that there is a contingent value of information sharing in collaborative S&OP. Finally, Danese et al. (2018) studied the transitions of firms to more advanced stages of S&OP maturity and found that there is no "best" sequence of implementation since each firm may follow an implementation path that is unique to its circumstances and dependent on the evolution stage of its S&OP process. In summary, despite the broad range of

environments and settings for firms that implement S&OP, the application of contingency theory in S&OP research is still developing and as such managers may not all be able to easily identify and make the required changes to the attributes of their organisations to harness the greatest benefits from S&OP.

5.2.5. Research objectives

Our review of the literature has shown that there is a rich body of research on coordination mechanisms but, as first observed over a decade ago by Crowston et al. (2006), few studies test the relative strengths of coordination mechanisms. S&OP is an industry-developed means through which coordination methods could be applied to bridge the marketing-operations divide and more generally across organisational functions. S&OP maturity models tend to advocate more closely-integrated organisations, but the broader management literature (e.g. Tushman and O'Reilly, 1996; Benner and Tushman, 2003; Gibson and Birkinshaw, 2004; Raisch et al., 2009) is starting to appreciate a more ambivalent view of integration/differentiation. However, with few exceptions such as the paper by Oliva and Watson (2011), such an ambidextrous approach is still uncommon in the S&OP operations management literature. There have been several survey-based studies on S&OP but these have limitations related to representativeness of the sample, size of the sample or theoretical underpinning. Similarly, apart from the exceptions (Thomé et al., 2014b; Ivert et al., 2015; Kaipia et al., 2017; Danese et al., 2018) noted earlier, applications of contingency theory in S&OP research are scarce and do not demonstrate how findings obtained for specific industries and cultures can be generalised (Thomé et al., 2012b; Pedroso et al., 2016; Kristensen and Jonsson, 2018). A large-scale survey that considers the effects of

S&OP coordination mechanisms on supply chain performance under various settings is therefore relevant and timely.

Our study intends to draw on coordination theory concepts from organisation science and contribute to the S&OP literature that is traditionally operations management-focused. We analyse the strength of the links between S&OP practices and overall supply chain performance using survey-based Structural Equation Modelling (SEM). We aim to answer the following research questions:

- ***RQ1***: Are individual S&OP coordinating mechanisms significantly linked to a firm's supply chain performance?
- ***RQ2***: If so, are any S&OP coordinating mechanisms more important when predicting whether a firm would derive benefits from S&OP?
- ***RQ3***: What are the environments and organisational settings under which some of these mechanisms can become more (or less) important?

5.3. Hypotheses Development

To determine the effect of various coordinating mechanisms of S&OP, it is first necessary to identify and define those that we adopted for our study. Thomé et al. (2014a & 2014b) propose a model that uses four mechanisms (meetings and organisation, measurement, technological integration and integration of plans). Tuomikangas and Kaipia (2014) propose a similar, but more comprehensive, S&OP coordination framework. This uses the six variables defined in Table 5-1 to represent S&OP coordination mechanisms.

Table 5-1: S&OP Coordinating Mechanisms (Tuomikangas and Kaipia, 2014)

S&OP Coordination Mechanism	Definition
S&OP Organisation	Formal organisational S&OP Structure
S&OP Process	Formal and standardised process for conducting S&OP
S&OP Tools and Data	Processes and tools for capturing, sharing, storing and refining data needed for decision making
Performance Management	Measurement and optimisation of firm performance
Strategic Alignment	S&OP as a link between company strategy and operational planning, and reinforcing the reaching of strategic business targets
S&OP Culture and Leadership	Culture and leadership required to support and enhance S&OP

Tuomikangas and Kaipia (2014)'s framework forms the starting point for our study though we have refined it as described below.

5.3.1. S&OP Organisation

To aid coordination, interactions between members in organisations can help provide clear signals about tasks, behaviours, and expectations of their roles as well as the roles of others and the relationships between them (Bechky, 2006). Some organisations may use "human integrators" (Lawrence and Lorsch, 1967b), "liaisons" (Galbraith, 1974) or "boundary spanners" (Heath and Staudenmayer, 2000) to act as intermediaries between interdependent adjacent functions in the value chain. Hierarchy can also be an efficient mechanism for coordinating a system comprising multiple specialised units but it is restricted by the size of the team and is less feasible in knowledge-based firms (Grant, 1996). Hierarchies are also unlikely to be effective in complex, uncertain environments because the number of exceptions can overload them (Lawrence and Lorsch, 1967b; Galbraith, 1974). Furthermore, Tsai (2002) found that among internal business units that compete with each other for market share, formal hierarchical structure *negatively* affects knowledge sharing.

In the context of S&OP, researchers have tended to consider "S&OP Organisation" in terms of roles and responsibilities rather than the formality of a hierarchy (Tuomikangas

and Kaipia, 2014). For example, there is often a designated owner for the S&OP programme (Grimson and Pyke, 2007; Iyangar and Gupta, 2013; Wagner et al., 2014; Tuomikangas and Kaipia, 2014). Grimson and Pyke (2007) propose that mature implementations of S&OP would include a formal S&OP function and executive level participation. There is agreement among researchers and practitioners that key internal stakeholders in the organisation participate in S&OP meetings (Ling and Goddard, 1988; Lapide, 2004a; Harwell, 2006; Milliken, 2008; Wagner et al., 2014; Tuomikangas and Kaipia, 2014). Consequently, we hypothesise:

H1*: S&OP Organisation is positively related to Supply Chain Performance.*

5.3.2. S&OP Process (S&OP Procedure/Schedule)

S&OP typically follows a process that begins with a baseline sales forecast and ends with the integration of information related to new product introduction and product obsolescence (Grimson and Pyke, 2007). However, in the context of coordination mechanisms, "S&OP Process" would refer to not just any series of actions or steps but those that are formal and standardised (Tuomikangas and Kaipia, 2014) to include written policies, rules, job descriptions, and standard procedures (Mintzberg, 1979; Martinez and Jarillo, 1989).

Furthermore, S&OP practitioners often advocate that there should be a defined, common S&OP calendar within an organisation (Lapide, 2004a; Boyer, 2009; Milliken, 2008; Smith et al., 2010), although some "leading companies" would strive for an "event-driven" S&OP process whereby management meets on an as-needed basis to deal with exceptions (Grimson and Pyke, 2007). S&OP meetings are also said to follow a standard process/format/agenda/protocol (Lapide, 2004a; Ivert and Jonsson, 2010,

Oliva and Watson, 2011; Swaim et al., 2016) and are conducted at least once a month (Ling and Goddard, 1988; Lapide, 2004a; Grimson and Pyke, 2007; Smith et al., 2010).

Researchers have uncovered some empirical evidence of the benefits of formal procedures. For example, in a study of collaboration by temporal virtual teams, Montoya-Weiss et al. (2001) found that the "process structure" coordination mechanism (which includes schedule deadlines, guidelines on pace of effort and specifications for time spent on tasks) positively moderates the negative effects of avoidance and compromise behaviours on performance. S&OP case study evidence suggests that there is potential for conflict and lack of coordination in the absence of a formal planning process (Oliva and Watson, 2011). Similarly, improved process flows were at least partly responsible for improvements in supply chain performance in two recent adopters of S&OP (Goh and Eldridge, 2015).

Practitioners often refer to an "S&OP Process" as the entire set of framework, methods and tools used to facilitate S&OP. To avoid ambiguity, we use the term "S&OP Procedure/Schedule" to describe the activities originally defined by Tuomikangas and Kaipia (2014) as "S&OP Process". Consequently, we hypothesise:

H2: *S&OP Procedure/Schedule ("Procedure") is positively related to Supply Chain Performance.*

5.3.3. S&OP Tools and Data (Information Acquisition/Processing)

Specialist functions, as described earlier, often have difficulty communicating with all the roles with whom they are interdependent. To reduce the amount of task uncertainty, the organisation can either reduce the amount of information that is processed or, more likely, increase its information processing capabilities (Galbraith, 1974). Furthermore,

equivocality (i.e. ambiguity) may also exist such that structural mechanisms have to enable debate, clarification, and enactment, beyond simply provide large amounts of data (Daft and Lenge, 1986). For the marketing-operations interface in S&OP, the two specialist functions can be encouraged to exchange information and consult each other when developing a coordinated plan (Tang, 2010) to, for example, reduce lead times or react to changes in forecasts (Kaipia et al., 2017).

To facilitate this exchange of information, S&OP data requirements should be well-defined (Ling and Goddard, 1988; Schrieber, 2005; Tuomikangas and Kaipia, 2014) and may be supplemented by data from external parties in the supply chain (Grimson and Pyke, 2007; Tuomikangas and Kaipia, 2014, Goh and Eldridge, 2015). Furthermore, this data typically needs to be processed effectively via the adoption of an appropriate IT platform, enterprise resource planning (ERP) system, or advanced planning system (Lapide, 2004b; Grimson and Pyke, 2007; Affonso et al., 2008; Ivert and Jonsson, 2010). In addition, it should be easy to share, retrieve or update S&OP-related data within the organisation (Grimson and Pyke, 2007; Milliken, 2008; Tuomikangas and Kaipia, 2014; Kaipia et al., 2017).

From a coordination perspective, "Information Acquisition/Processing" is more representative of the activities originally described as "S&OP Tools and Data" by Tuomikangas and Kaipia (2014). Consequently, we hypothesise:

***H3**: Information Acquisition/Processing ("Information") is positively related to Supply Chain Performance.*

5.3.4. Performance Management

Performance management can be viewed as a form of "output control" which, in its simplest form, is the evaluation of files, records, and reports submitted by the organisational units to senior management (Martinez and Jarillo, 1989). Instead of specifying behaviours, the organisation sets goals to be achieved and the employees select the behaviours that lead to goal accomplishment (Galbraith, 1974). Another related concept is the "direct supervision" or "tracking" of interdependent tasks in project management, in which managers use project tracking systems to identify activities that are late and then use their authority to motivate the people responsible for the late tasks (Malone and Crowston, 1994).

Olhager et al. (2001) indicate that the use of reports (where past and current performance as well as future plans are easily visualised) can guide managers in S&OP. Collin and Lorenzin (2006) discuss putting in place performance metrics to "continuously understand customer milestones" within the deployment of an integrated project management tool. Hulthén et al. (2016) propose a framework to measure the S&OP process with standardised measures that would enhance organisational transparency and improve process analysis, ultimately leading to organisational changes.

S&OP performance metrics should balance between the interests of various parties in the organisation (Grimson and Pyke, 2007; Thomé et al., 2012b; Tuomikangas and Kaipia, 2014). Performance issues and bottlenecks should be effectively addressed and followed-up upon after S&OP meetings (Milliken, 2008; Tuomikangas and Kaipia, 2014; Van Hove, 2016). Targets derived using the S&OP process should be tracked against actual performance (Ling and Goddard, 1988; Thomé et al., 2012a; Wagner et al., 2014). S&OP performance metrics should also have multiple dimensions from the

financial, operations or process perspectives (Ling and Goddard, 1988; Grimson and Pyke, 2007; Milliken, 2008; Iyangar and Gupta, 2013; Tuomikangas and Kaipia, 2014). Consequently, we hypothesise:

***H4**: Performance Management is positively related to Supply Chain Performance.*

5.3.5. Strategic Alignment

Organisational alignment can be achieved in dynamic environments via "feedback" (Van de Ven et al., 1976) and "mutual adjustment" (Thompson, 1967; Van de Ven et al., 1976; Mintzberg, 1979; Okhuysen and Bechky, 2009). Even when interests are aligned, coordination problems can persist if actions are not aligned because individuals may not have comprehensive knowledge of how others will behave in situations of interdependence (Gulati et al., 2005). Behaviours of performers that "occur in one subtask cannot be judged as good or bad per se … but are more effective or ineffective depending upon the behaviours of the other subtask performers" (Galbraith, 1974). Adversarial relationships between the commercial side and the operations side of business have been well-documented (Wallace, 2006) but S&OP is one means through which "constructive engagement in validation" can take place (Oliva and Watson, 2011). This increases alignment between product offering and promotions plans with a shared understanding of constraints and collective ownership of the plan. A key outcome of S&OP is a vertically and horizontally aligned set of marketing, development, manufacturing, sourcing, and financial plans that enable the on-going balancing of supply and demand (Wagner et al., 2014).

In practice, S&OP strategies are most often focused on driving growth through new product introductions (Olhager et al., 2001; Wallace, 2006; Tuomikangas and Kaipia,

2014; Goh and Eldridge, 2015) or the entering of new markets or on boarding of new customers (Muzumdar and Fontanella, 2006; Mello and Esper, 2007; Tuomikangas and Kaipia, 2014). It should also provide an opportunity for feedback or adjustment to sales plans based on capacity or other operational issues (Affonso et al., 2008; Grimson and Pyke, 2007; Tuomikangas and Kaipia, 2014; Van Hove, 2016). Consequently, we hypothesise:

H5*: Strategic Alignment is positively related to Supply Chain Performance.*

5.3.6. S&OP Culture

An organisation's culture can be described as a set of known values that are shared throughout the organisation. This culture can be reinforced by training, transfer of managers, career path management and measurement and reward systems (Martinez and Jarillo, 1989). In the supply chain context, Mentzer et al. (2001) frame several elements of organisational culture (including trust, commitment, vision and top management support) as antecedents to a firm's supply chain orientation, which is the recognition by an organisation of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain. Tuomikangas and Kaipia (2014) identify similar elements of an organisation's culture that coordinate an S&OP programme. In particular, there should be effective communications of business objectives and vision (Godsell et al., 2010; Tuomikangas and Kaipia, 2014; Van Hove, 2012 & 2016) and trust among employees or departments within the company (Hadaya and Cassivi, 2007; Mello, 2010; Oliva and Watson, 2011; Thomé et al., 2012a). Employees should be empowered to contribute actively to the company's plans at various levels (Ling and Goddard, 1988; Lapide, 2004a; Lapide, 2005; Muzumdar and Fontanella, 2006; Oliva and Watson, 2011; Thomé et al., 2012a; Wagner et al., 2014).

Senior management should also be supportive of S&OP (Grimson and Pyke, 2007; Thomé et al., 2012a; Tuomikangas and Kaipia, 2014; Van Hove, 2012).

Although Tuomikangas and Kaipia (2014) adopt the term "S&OP Culture and Leadership", earlier research places the emphasis on the organisational culture aspect of this coordinating mechanism, so we have chosen to rename this mechanism as simply "S&OP Culture". Consequently, we hypothesise:

***H6**: S&OP Culture is positively related to Supply Chain Performance.*

5.3.7. Theoretical model

Figure 5-1 shows the theoretical model that was developed for this study which incorporates our six hypotheses that link the coordination mechanisms with Supply Chain Performance. Earlier studies have highlighted that S&OP implementation can lead to a variety of supply chain performance improvements (Thomé et al., 2012a). These include: increased responsiveness to changes in demand (Harwell, 2006; Hadaya and Cassivi, 2007); reduced inventory (Muzumdar and Fontanella, 2006; Boyer, 2009; Lapide, 2004b; Goh and Eldridge, 2015); reduced stock-outs or back-orders (Schrieber, 2005; Wallace, 2006); reduced lead time to customers (Collin and Lorenzin, 2006; Nakano, 2009; Goh and Eldridge, 2015); and increased responsiveness to disruptions in supply (Schrieber, 2005; Smith et al., 2010; Ivert and Jonsson, 2010). "Supply Chain Performance" is therefore defined in our model as an endogenous latent variable indicated by fill rate, inventory levels, lead time and flexibility.

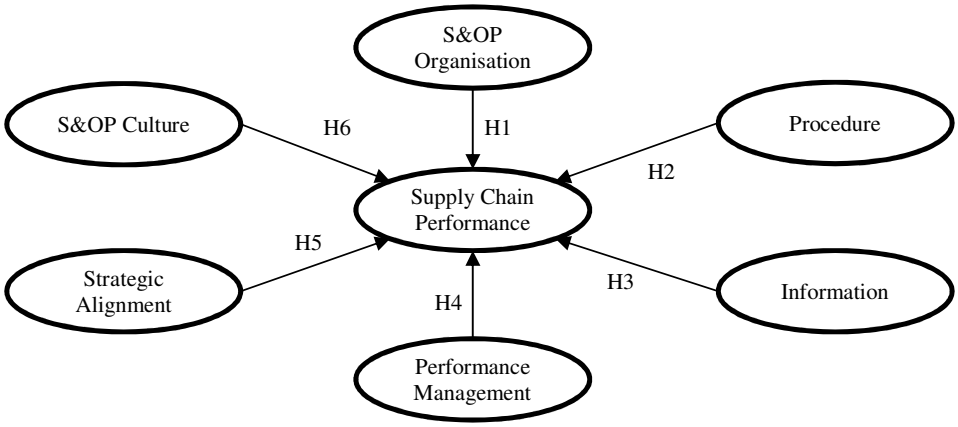


Figure 5-1: Theoretical Model and Hypotheses on S&OP Coordinating Mechanisms

To ensure that the structural model is parsimonious, we only consider the total paths between the individual S&OP coordination mechanisms and Supply Chain Performance, rather than being mediated by second-order constructs such as "S&OP maturity". In addition, firm size, daily order volume, product variety and product lifecycle have been included as ordinal control variables in our study. Country (from which region and economic maturity can be derived) and industry (later aggregated into industry sectors) have been included as categorical variables. The six main hypotheses can then be extended to explore the contingent effect of these moderating variables.

In developing a theoretical model, equivalent models should be considered to avoid confirmation bias (Shah and Goldstein, 2006). Equivalent models are those that are indistinct from the original model in terms of goodness of fit to the data but with a distinct substantive meaning in terms of the underlying theory (MacCallum et al., 1993). In our study, equivalent models can be generated by reversing the causality path between any of the coordination mechanism and the Supply Chain Performance variables in Figure 5-1. However, the adoption of a coordination theory perspective, in which effective coordination mechanisms are those that help to achieve a coordinated

result, means that reversed causality (e.g., "Strong Supply Chain Performance improves Strategic Alignment") is implausible.

5.4. Methodology

5.4.1. Measurement scales and survey design

The survey method was the primary approach for this research, supplemented by a qualitative analysis of comments provided by respondents. Except for the control variable "firm size", the unit of analysis in this study was the business unit (as opposed to the firm), because firms typically have independent entities or lines of business that run separate S&OP programmes. Prospective respondents were those informants who had implemented, led or regularly participated in their business units' S&OP programmes.

In August 2014, an exploratory pilot survey was first launched on 25 organisations that implemented S&OP, with the intent of gathering preliminary data on the motivation that these companies had in implementing S&OP and the challenges that they faced. Other objectives were to identify research themes that would be of interest in a larger scale survey and solicit feedback from prospective respondents on survey design. This pilot survey also gathered valuable organisational profile information (i.e. potential instrumental, confounding or control variables in our theoretical model). This include product characteristics (e.g. the typical range of order volumes and product lifecycles), the percentage of SKUs included in S&OP programmes and the S&OP planning level (i.e. SKU, product family or product category levels). For example, this exploratory survey revealed that among this small dataset of companies that claimed to have implemented S&OP, typically just 80% of SKUs were included in S&OP programmes,

52% of S&OP implementations performed consensus forecasting at a rather granular level (below product-family level) and 16% of respondents professed no discernible impact from S&OP on their organisations' supply chain performance (which raised the question why).

The design of the subsequent large-scale survey began with a search of the literature for a set of measurement scales for S&OP coordination mechanisms. Our approach was closely aligned with the one outlined in Thomé et al. (2016) but extended to three main avenues: 1) papers on "S&OP" or "supply chain coordination/collaboration/integration" published in peer-reviewed operations management academic journals, 2) papers on "coordination", "cross-functional teams" or "organisational integration" in organisational science, marketing or strategic management academic journals, as well as 3) articles from S&OP practitioner journals and book chapters. However, no existing set of measurement scales was found to be entirely appropriate. For instance, Thomé et al. (2014a & 2014b)'s measurement scale comprised only four mechanisms (meetings and organisation, measurement, technological integration and integration of plans), each of which comprise just two to three measurement items. On the other hand, Swaim et al. (2016)'s constructs represent antecedents (organisational integration, standardised S&OP processes, organisational priority and organisational engagement) rather than coordination mechanisms of effective S&OP. Given the lack of a comprehensive established scale on S&OP coordination mechanisms, a new scale had to be created. First, several statements related to each coordination mechanism were designed to represent the corresponding constructs. These statements were based on findings from the both the academic and practitioner literature and included as many relevant keywords as possible. They were also designed to be reflective rather than formative (Jarvis et al., 2003; Shah and Goldstein, 2006).

In this study, we adopt a premise that is consistent with researchers such as Tuomikangas and Kaipia (2014). In effect, S&OP exists in many forms, ranging from basic S&OP to highly sophisticated versions. Firms may design their S&OP programmes with the broad characteristics that involve the creation of a cross-functional set of plans, but with varying levels of maturity in the individual coordinating mechanisms, depending on the specific business environment. To uncover whether the presence or absence of an S&OP coordinating mechanism would help explain a firm's supply chain performance, data from those firms that have apparently implemented a consistently high level of S&OP mechanisms are clearly needed to fulfil the purpose of our study. Yet, firms with "immature" implementations of S&OP that reflect minimal adoption levels of the coordination mechanisms are also required to represent the other extreme of the range of S&OP implementations prevalent in industry. Consequently, the survey questionnaire has been designed to capture data from these extremes as well as the intermediate range of firms in terms of S&OP mechanism adoption.

In addition, the measurement items for supply chain performance have been designed to be a standardised means for respondents to report (rather than instruct respondents on how to measure) the extent an S&OP programme has led to an improvement in the supply chain metrics against an expected baseline performance. In practice, this may be assessed (outside of the survey instrument) by respondents across products or over time, which has been discussed separately in studies such as Goh and Eldridge (2015).

Before the large-scale survey was launched, a Q-sort pre-test was conducted with ten supply chain practitioners and academics. These ensure that questions were clear and unambiguous and each was reflective of a construct (i.e. indicators within a construct share a common theme and are interchangeable to a large extent) (Jarvis et al., 2003). In our finalised survey, respondents were presented with a series of statements, to which

they were asked to state the extent that they agree with each of them, based on their experience with S&OP in their business units. A 7-point Likert scale was used with "1" for "strongly agree" and "7" for "strongly disagree". At least five reflective indicators per construct were designed and these were then reduced during the Exploratory Factor Analysis (EFA) stage. The survey as administered to respondents, including questions that were removed during the EFA process, can be found in Appendix A. Measurement items (i.e. survey questions) that survived the EFA reduction process, descriptive statistics and factor loadings can be found in Appendix B.

To solicit honest answers, the survey was anonymous and respondents were not asked to identify themselves or their companies by name. At the end of each section, respondents were given opportunities to make elaborative open-ended comments. These comments were intended to help provide some context to the reflective factor-based measurement model. Owing to the wide range of firms and industries surveyed in this study, a self-reported standardised measuring scale was used. Respondents were asked to assess the effectiveness of S&OP across several metrics at their organisations, which may be against historical performance before S&OP was implemented for a portfolio of products or across product lines (i.e. against the supply chain performance of the subset of SKUs that were not incorporated or not yet incorporated within S&OP programmes). Past examples of self-reported performance measures in large-scale studies in the supply chain or manufacturing context can also be found in Tracey et al. (1999), Sawhney and Piper (2002) and Thomé et al. (2014a).

5.4.2. Survey sampling

Conventional survey sampling tends to use lists of organisations and target respondents using job titles, but in this study, it is imperative that we survey respondents who are verifiably experienced practitioners in S&OP who work within companies that have implemented S&OP. This is an important prerequisite for prospective respondents, as some companies may have implemented just some elements of internal coordination that is not necessarily S&OP, while others may claim expertise and experience in S&OP that they do not possess. These two examples illustrate the risks associated with all survey-based research studies of S&OP. To mitigate these risks and maintain the integrity of the eventual survey data, a strict screening policy was adopted at the onset of our study and this is now described.

In February 2016 to January 2017, to actively seek out S&OP practitioners from a diverse representation (e.g. not just those that obtained positive results from S&OP), personalised invitations were sent to about 3,600 individual supply chain professionals who met the criteria for experience in S&OP, from a global pool of more than 15,000 individuals in several S&OP interest groups on LinkedIn (a professional social networking platform). Active participation in an interest group can be a useful indicator that prospective respondents are actually practitioners in S&OP rather than just interested observers. As part of the data collection protocol, three levels of screening were implemented. Initially, all potential respondents were individually pre-qualified before they were invited to the survey. These criteria for targeted respondents include those people who have "S&OP" (or closely-related terms such as "SIOP" – Sales, Inventory and Operations Planning) in their job titles, job descriptions, skills or profile summaries in LinkedIn. They must also have had at least two years' experience in S&OP-related roles in their employment history. This pre-qualification ensures that

respondents had experienced a full year's cycle in S&OP and were likely involved in the adding/retiring of products from the S&OP portfolio as firms undergo cycles of exploration-exploitation. To avoid bias arising from surveying just a single type of respondent, people with different roles in S&OP were included in the pool of targeted respondents.

During the actual survey, as a form of secondary screening, APICS's definition of S&OP was provided in an introductory text before the survey began, following which respondents were asked whether: 1) S&OP as described was formally adopted at their organisations; 2) only collaborative forecasting (informal S&OP) was adopted; or 3) S&OP was not adopted. Qualtrics was the survey tool used to conduct a self-administered questionnaire. We received 684 complete responses, representing a response rate of about 19%.

Responses were then further screened prior to analysis. Only complete responses were saved and therefore no answers were imputed. We discarded 45 responses in which the respondents appeared disengaged (e.g., providing the same answers to nearly all the question items and failing to answer the "attention trap" questions correctly). Six respondents indicated they did not practise S&OP. Another 64 respondents did not formally practise S&OP at their current organisations (even though they may be familiar with S&OP). These 64 responses were disregarded for our analysis but were retained as a control group to be used to check for selection and self-selection biases. One response was received after the data-processing cut-off date. Consequently, 568 responses (representing organisations that had implemented S&OP according to the APICS definition) were used for analysis. Out of these 568 respondents, 143 (25%) provided further elaboration on their responses via optional input fields, which were also subjected to further analysis.

The eventual dataset comprised respondents who represent a wide cross-section of S&OP roles, industries and geographies. Table 5-2 shows the profile of respondents in the survey, the business units whose S&OP implementations were reported on and the characteristics of the products that respondents' business units dealt with. Respondents from 87 countries were represented. A large proportion (43%) were part of large organisations that had more than 50,000 employees while 47% of the business units were highly experienced (at least five years) in implementing S&OP.

Table 5-2: Respondent, Business Unit and Product Profiles (N=568)

Role		Sub-Region	
Demand planning	221	Western & Northern Europe	81
Procurement & supply management	135	USA/Canada	75
Manufacturing & operations management	73	Latin America	67
Logistics management	44	Sub-Saharan Africa	63
General management	20	East Asia & Pacific	59
Sales or account management	13	Middle East & North Africa	57
Finance	4	Central & Southern Europe	54
Other	58	South East Asia	50
		South Asia	37
		Eastern Europe & CIS*	25

No. of Employees (Firm)		Industry	
50,000 and above	242	Food Products	88
10,000 to 49,999	155	Life Science and Healthcare Products	59
5,000 to 9,999	63	Energy and Chemicals	54
1,000 to 4,999	74	Household and Personal-Care Products	53
500 to 999	18	Beverages	51
<500	16	High-Tech and Consumer Electronics	48
S&OP Experience		Industrial Equipment	41
> 10 years	95	Automotive	41
> 5 to 10	171	Retail and Distribution (Multi-Products)	31
> 2 to 5	160	Apparel, Footwear and Textiles	17
0-2	142	Agriculture and Agribusiness	15
		Aerospace and Defense Equipment	11
		Mining	9
		Other	50

Daily Order Volume		SKU Variety		Product Lifecycle	
500 orders or more	243	>5,000 SKUs	163	>10 years	114
200 to 499	104	2,000 to 5,000	109	>5 to 10	126
50 to 199	143	500 to 1,999	116	>2 to 5	163
10 to 49	56	100 to 499	129	>1 to 2	92
<10	22	<100	51	1 or less	73

* Commonwealth of Independent States

In this study, we excluded respondents who did not practise S&OP at their organisations and resultantly there were no instances in our final dataset in which all S&OP coordinating mechanisms were completely absent at each organisation surveyed. As described earlier, we however did not exclude respondents on the basis of minimum mechanism adoption levels, as we could not rule out that in certain environments and settings (in relation to ***RQ3***), some firms may be able to exploit the benefits of S&OP with the presence of just a few (and not all) of the coordinating mechanisms.

5.4.3. Factor reduction, model specification and model fitting

In covariance structure modelling, the practice of model modification to improve fit may lead to capitalisation on chance characteristics of the data, thus raising the question of whether model modifications would generalise to other samples or to the population (MacCallum et al., 1992). To reduce the likelihood of capitalisation on chance during development of our model, we divided our sample into two equal sub-samples (each N=284). The first sub-sample was used to carry out the Exploratory Factor Analysis (EFA) while the second was used to carry out Confirmation Factor Analysis (CFA). Upon establishment of an acceptable model, the roles of the two sub-samples were reversed to carry out cross-validation. Should both sub-samples have similar model fit statistics, they would then be re-combined as the overall sample to be analysed.

During the EFA phase using the first sub-sample, SPSS 23 was used to conduct a factor reduction analysis and check for factor loading. The factor analysis of the responses received indicated that variables could be grouped into a set of seven underlying factors to a large extent based on the Maximum Likelihood estimation method. Cumulative variance explained by the seven distinct factors in the first sub-sample is 72.6%, which

is above the minimum of 50% (Fornell and Larcker, 1981). The CFA conducted on the second sub-sample confirmed the factor structure established during the EFA on the first sub-sample. The goodness of fit statistics for the measurement model based on both sub-samples and the overall sample are shown in Table 5-3 (where $\chi 2$ = Chi-Square, Df = Degrees of freedom, CMIN/df = Relative chi-square, CFI = Comparative fit index; RMSEA = Root mean square error of approximation fit index; SRMR = Standardised root mean square residual). Results of the cross-validation analysis indicate that fit statistics for the two sub-samples are similar and we can conclude that the model development process was not capitalising on chance relationships in the data.

Table 5-3: Model Fit for Measurement Model and Cross-Validation

Phase	Indicator/ Metric	Sub-Sample 1 (N=284)	Sub-Sample 2 (N=284)	Overall Sample (N=568)
EFA	Variance explained	72.6%	65.3%	57.1%
CFA	$\chi 2$	511.27	416.84	583.08
	Df	258	258	258
	CMIN/df	1.98	1.62	2.26
	CFI	0.940	0.945	0.953
	RMSEA	0.059	0.047	0.047
	SRMR	0.059	0.052	0.046

Analysis of the measurement model for the overall sample in AMOS 22.0 showed that average loading of items to the respective factors was 0.7395 (p<0.001 for all items whose regression weights were not fixed). The model fit statistics for the overall sample meet Hu and Bentler (1999)'s recommended thresholds (CFI >0.95, RMSEA<0.06 and SRMR <0.08). Therefore, good model fit was obtained.

The CFA also provided additional measures for validity and reliability. The construct correlation matrix in Table 5-4 shows the correlations between factors. To establish discriminant validity, the square root of the Average Variance Extracted (AVE) should not be less than any correlation with another factor (Fornell and Larcker, 1981). All factors achieved this criterion.

Table 5-4: Means, Standard Deviations (S.D.) and Construct Correlation

Factor	Mean	S.D.	1	2	3	4	5	6	7
1 Supply Chain Performance	2.34	2.02	***0.71***						
2 S&OP Organisation	1.63	1.24	0.40	***0.75***					
3 Procedure	1.47	1.16	0.27	0.66	***0.73***				
4 Information	2.57	2.10	0.56	0.54	0.49	***0.72***			
5 Performance Management	2.18	1.76	0.54	0.50	0.51	0.63	***0.76***		
6 Strategic Alignment	2.60	1.94	0.62	0.46	0.36	0.63	0.66	***0.72***	
7 S&OP Culture	2.34	2.07	0.54	0.50	0.47	0.57	0.66	0.66	***0.82***

Note: Square root of the AVE on the diagonal (in bold and italics)

Table 5-5 shows the Cronbach's Alpha (α), AVE, Maximum Shared Variance (MSV), Average Shared Variance (ASV) and Composite Reliability (CR). To establish reliability, CR should be greater than 0.70 (Hair et al., 2008). This threshold was achieved for all factors. Cronbach's Alpha (α) values were all well above 0.70. Convergent validity is concerned with whether a set of items share a high proportion of common variance. To establish convergent validity, the AVEs should be greater than 0.50 (Hair et al., 2008) and this threshold was achieved for all factors. Normality, skewness and kurtosis were checked and found acceptable. Minimum sample size was well-exceeded for adequate power of 0.80 (MacCallum et al., 1996).

Table 5-5: Reliability, Convergent Validity and Discriminant Validity Measures

Factor	α	CR	AVE	MSV	ASV
1 Supply Chain Performance	0.83	0.83	0.50	0.39	0.25
2 S&OP Organisation	0.74	0.80	0.57	0.44	0.27
3 Procedure	0.76	0.76	0.52	0.44	0.23
4 Information	0.82	0.81	0.52	0.40	0.33
5 Performance Management	0.81	0.84	0.57	0.43	0.34
6 Strategic Alignment	0.80	0.76	0.52	0.43	0.33
7 S&OP Culture	0.86	0.89	0.68	0.43	0.33

5.4.4. Tests of invariance, endogeneity and bias

Configural invariance and metric invariance tests between moderating groups (such as firm size, experience in S&OP, product variety and product lifecycle) were also conducted. Test results showed that there were configural invariance and at least partial

metric invariance (i.e., at least one item to define the scale of each latent construct is metrically invariant) (MacKenzie et al., 2011). Therefore, the factor structure and loadings were sufficiently equivalent for results across groups to be meaningful. Given that data collection took place over a period of many months, an invariance test was also conducted between early and late respondents, but results generally show insignificant variance across these two groups.

Common method variance (i.e., variance that is attributable to the measurement method rather than to the constructs the measures represent) is a potential problem in behavioural research (Podsakoff et al., 2003). In this study for example, some respondents who were responsible for implementing S&OP at their companies might be prone to overstating Supply Chain Performance and the benefits of S&OP at their business units, thus inflating their own contributions to their companies' performance. However, an examination of the survey data revealed that respondents in this study were not unanimous in their assessment of S&OP outcomes. Views at both extremes were represented, with 34% of respondents reporting no or little impact of S&OP on supply chain performance at their organisations. Nonetheless, given the potential for common method bias to occur, tests for the presence of common method variance were carried out. As Harman's single-factor test is an insensitive test of common method variance, the common-latent-factor approach (Podsakoff, et al., 2003) was used, but results showed that common method variance was not a major concern in the sample.

A more general problem in establishing causal models is endogeneity, in which the effect of an independent variable on a dependent variable cannot be interpreted (Antonakis et al., 2010; Ullah et al., 2018) because the model includes common-method variance, omitted causes, predictor-outcome simultaneity or measurement errors. An example of a possible omitted cause would be a "social desirability bias" factor arising

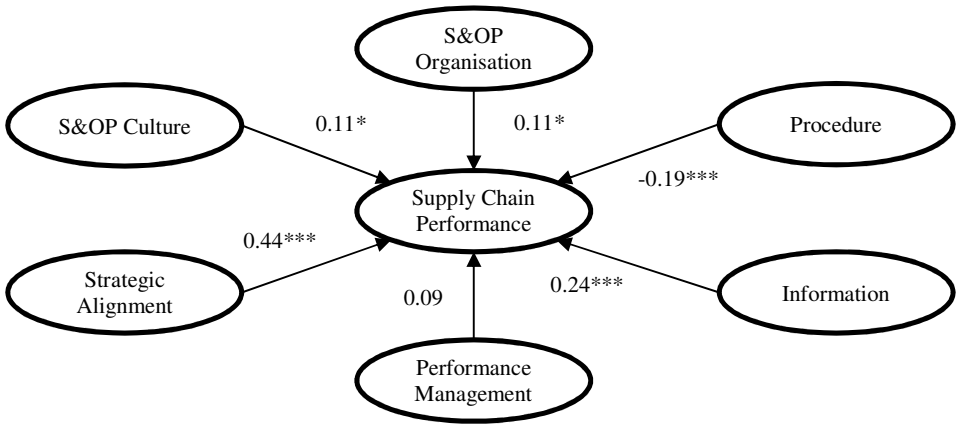
from some practitioners that may have a vested interest in possibly overstating the maturity of individual coordinating mechanisms or S&OP outcomes, which can be detected via the triangulation of opinion-based variables against more objective instrumental variables. Endogeneity would be present if the error term u in the dependent variable y_1 (as predicted by the independent variable y_2) has a correlation (ψ) to y_2 that is not zero. This leads to an inconsistent regression weight that can be corrected by the two-stage least-square procedure. In our model, the predictors (i.e. the six coordination mechanisms) are individually found to be correlated to various extents to the exogenous variables of firm size, experience, variety, daily orders, lifecycle and economic maturity, which are used as instrumental variables. In stage 1, we regressed the coordinating mechanisms on the exogenous variables and obtained the predicted values ($\hat{y}_2$) for the strength of each mechanism in every sample. In stage 2, the predicted strength of each coordinating mechanisms was computed. We then ran the Durbin-Wu-Hausman chi-squared test (Davidson and MacKinnon, 1993) and found that endogeneity was not a significant problem (p=0.254 for the null hypothesis that the coordinating mechanisms are exogenous).

One drawback of pre-qualifying a respondent pool is that we could inadvertently introduce selection bias because a survey of self-professed S&OP specialists may over-represent companies that had the greatest propensity to gain from S&OP (such as large firms with high product variety). Similarly, self-selection bias may occur, whereby S&OP advocates who ran successful S&OP programmes could be postulated to be more likely to respond to a survey on S&OP than sceptics. We checked for bias via propensity score matching (Rosenbaum and Rubin, 1983) between the "treatment group" of S&OP adopters and a small "control group" of 64 respondents whose companies did not (or could not) adopt formal S&OP. Using four firm/product characteristics (firm size, daily

order volume, product variety and product lifecycle) as confounding covariates, our test showed very high overlap in propensity scores between the two groups, less than 5% unmatched control samples and less than 0.05 average imbalance in covariates (|*d*|). Thus, selection bias (attributable to a firm's predisposition to S&OP) and self-selection bias (comparable to non-response bias) were insignificant in our sample.

5.5. Results

Figure 5-2 shows the standardised regression weights of the various S&OP constructs (***RQ1***) to Supply Chain Performance, while Table 5-6 shows the critical ratios of the pair-wise differences in the relative strengths of the six mechanisms (***RQ2***).



Controls on Supply Chain Performance	
Firm Size	0.00 (ns)
S&OP Experience	-0.05 (ns)
Daily Orders	-0.01 (ns)
Product Variety	-0.03 (ns)
Product Lifecycle	0.00 (ns)

*** $p<0.001$, ** $p<0.01$, * $p<0.05$
(ns): Not significant

Figure 5-2: Structural Modelling Results (Standardised Coefficients)

Table 5-6: Critical Ratios for Differences between Unstandardised Path Coefficients

Factor	1	2	3	4	5	6
1 S&OP Organisation	0.00					
2 Procedure	3.83 ***	0.00				
3 Information	0.30	5.91 ***	0.00			
4 Performance Management	1.07	4.12 ***	1.68 *	0.00		
5 Strategic Alignment	2.29 **	9.39 ***	2.49 **	3.78 ***	0.00	
6 S&OP Culture	1.27	4.64 ***	2.42 **	-0.19	4.57 ***	0.00

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Our results indicate that:

- Strategic Alignment (***H5***) had the strongest positive effect on Supply Chain Performance, compared to all other mechanisms studied.
- Information Acquisition/Processing (***H3***), S&OP Organisation (***H1***) and S&OP Culture (***H6***) also had significant positive effects on Supply Chain Performance.
- S&OP Procedure/Schedule (***H2***) had a highly significant *negative* relationship with Supply Chain Performance.
- Hypothesis ***H4*** (Performance Management) was not supported at the 5% level, albeit marginally (p=0.057).

On their own, firm size, years of S&OP experience, daily order volume, product lifecycles and product variety had no significant effects on Supply Chain Performance.

5.5.1. Moderating effects of industry, economic maturity and region

Table 5-7 shows the results of the moderation analysis for several categorical variables included in the survey. Economic maturity (either "emerging or "mature") was derived

from respondents' locations, according to the classification by the International Monetary Fund. For meaningful comparisons of "industry" as a moderator, industries within each cluster should share common characteristics but we were also constrained by a minimum number of respondents needed to maintain the statistical power of the SEM model (MacCallum et al., 1996). Consequently, we aggregated industry into three clusters:

- "Food": Industries that deal with food processing, beverages and agricultural products that are heavily influenced by factors such as perishability and uncertainty in demand and the supply of raw materials (Noroozi and Wikner, 2017).
- "Consumer/Tech": Industries that deal with consumer *non-food* products (e.g., apparel and footwear; household and personal care products; consumer electronics; and general retail and distribution.
- "Auto/Industrial": Heavy industries such as automotive, aerospace & defence equipment, energy & chemicals, industrial equipment and mining.

There were insufficient respondents from the life science & healthcare industry and these samples were excluded from the industry cluster group moderation analysis. In Table 5-7 and Table 5-8, to investigate ***RQ3***, unstandardised coefficients *b* (instead of standardised β) are shown so that the relative magnitudes of each coordination mechanism across the moderating variables can be compared. In addition to the significance of path coefficients, the significance of individual moderating effects (via one-tail difference tests) is also presented.

Table 5-7: Group Moderation Analysis Results for Categorical Variables

Moderator \ Hypothesis		Samples (N)	*H1* S&OP Organ-isation	*H2* Proced-ure	*H3* Inform-ation	*H4* Perform-ance Manage-ment	*H5* Strategic Align-ment	*H6* S&OP Culture
Overall		568	0.18 *	-0.28 ***	0.20 ***	0.09	0.38 ***	0.08 *
Industry Cluster	Consumer/ Tech	149	0.15	-0.22	0.13	0.13	0.32 ***	0.12
	Food	154	0.12	-0.36 **	0.19 *	0.07	0.43 ***	0.14
	Auto/ Industrial	156	0.39 *** ##	-0.35 **	0.12	0.19 ** #	0.42 ***	-0.05
Economic Maturity	Emerging	273	0.16	-0.26 **	0.08	0.09	0.40 ***	0.09
	Mature	295	0.19 *	-0.26 **	0.27 *** ###	0.08	0.35 ***	0.08
Region	Americas	142	0.12	-0.09	0.21 *	-0.01	0.42 ***	0.08
	Asia	146	0.07	-0.23	0.19 *	0.37 ** ###	0.14 ###	0.11
	Europe	160	0.24	-0.47 **	0.22 **	0.14 *	0.32 ***	0.14 **
	Mid-East & Africa	120	0.24	-0.33 **	0.16	0.03	0.53 ***	0.01

Notes: Coefficients are unstandardised regression weights (b); Significance of path coefficients: * $p<0.05$, ** $p<0.01$, *** $p<0.001$; Significance of moderating effect: # $p<0.1$, ## $p<0.05$, ### $p<0.01$

This analysis reveals that:

- In all three industry clusters, Strategic Alignment was the mechanism that had the greatest impact on Supply Chain Performance. The automotive/industrial products cluster also derived significantly better Supply Chain Performance from S&OP programmes that had formal S&OP Organisations (p=0.020).and were supported by strong Performance Management (p=0.091).
- A highly formalised S&OP Procedure/Schedule was found to inhibit Supply Chain Performance improvement, regardless of economic maturity, industry or region.

- Unlike in emerging markets, strong Information Acquisition/Processing had a significant and more discernible impact on Supply Chain Performance in mature markets (p=0.010).
- In the Asia-Pacific, significantly better Supply Chain Performance was obtained by organisations that had strong Performance Management (p=0.008) but not necessarily strong Strategic Alignment (p=0.003). In the Americas and Middle East & Africa, the effect of Performance Management was largely absent.

5.5.2. Moderating effects of firm and product characteristics

Table 5-8 shows the results of two-group moderation analyses using some of the original ordinal control variables converted to moderators. The results lend support to the following key observations:

- When product variety is large, the value of investing in advanced methods of information acquisition and processing is very significantly higher (p=0.018) compared to when product variety is low.
- Again, a highly formalised S&OP Procedure/Schedule was found to inhibit Supply Chain Performance improvement and this effect was consistent and significant across the board, regardless of an organisation's size, years of S&OP experience or product profiles.
- As a business unit becomes more mature in its S&OP journey, the importance of having well-defined S&OP Organisation and a strong Information Acquisition/Processing capability increases (p=0.104 and p=0.082 respectively)
- Increasing firm size marginally strengthened the positive relationship between S&OP Organisation and Supply Chain Performance (p=0.076). However,

increasing firm size also significantly strengthened the negative relationship between formalised S&OP Procedure/Schedule and Supply Chain Performance (p=0.040).

Table 5-8: Group Moderation Analysis Results for Ordinal Variables

Moderator \ Hypothesis		Samples (N)	*H1* S&OP Organ-isation	*H2* Proced-ure	*H3* Inform-ation	*H4* Perform-ance Manage-ment	*H5* Strategic Align-ment	*H6* S&OP Culture
Overall		568	0.18 *	-0.28 ***	0.20 ***	0.09	0.38 ***	0.08 *
S&OP Experience (years)	High (≥5)	266	0.27 **	-0.35 ***	0.27 *** #	0.08	0.34 ***	0.10
	Low (0-5)	302	0.10	-0.25 **	0.16 **	0.13	0.40 ***	0.07
Firm Size (employees)	Large (≥50,000)	242	0.30 ** ##	-0.43 *** #	0.18 **	0.10	0.38 ***	0.14 ** ##
	Small (<50,000)	326	0.10	-0.19 *	0.24 ***	0.09	0.36 ***	0.04
Product Lifecycle (years)	Long (>5)	240	0.23 *	-0.30 ***	0.30 *** ##	0.09	0.34 ***	0.05
	Short (0-5)	328	0.16	-0.28 **	0.13 *	0.08	0.40 ***	0.11 *
Daily Orders	High (≥500)	243	0.00	-0.23 *	0.16 **	0.21 * ##	0.36 ***	0.12 *
	Low (<500)	325	0.30 *** ##	-0.31 ***	0.22 ***	0.03	0.37 ***	0.07
Product Variety (SKUs)	High (≥2,000)	272	0.17	-0.30 ***	0.28 *** ##	0.14 *	0.43 ***	0.01
	Low (<2,000)	296	0.17	-0.26 **	0.11	0.07	0.34 ***	0.15 ** ##

Notes: Coefficients are unstandardised regression weights (b); Significance of path coefficients: * p<0.05, ** p<0.01, *** p<0.001; Significance of moderating effect: # p<0.1, ## p<0.05, ### p<0.01

5.6. Discussion

5.6.1. The links between coordinating mechanisms and supply chain performance

Our study has shown that organisations that have achieved a high degree of Strategic Alignment can expect to achieve the greatest improvement to Supply Chain Performance. Some respondents also highlighted that S&OP provides a platform for arriving at a consensus based upon "one source of truth" (i.e. avoidance of equivocality). Furthermore, our results suggest that when a firm needs to manage a large variety of products, the value of investing in advanced methods of information acquisition and processing increases very significantly. This is unsurprising and supports Kaipia et al. (2017)'s observation that point-of-sales data is most valuable when a firm manages a multi-product production process with capacity constraints. However, while data availability was generally considered to be important, our respondents held a range of opinions as to what constitutes an appropriate analysis tool varying from spreadsheet-based to other more advanced planning tools. One respondent hinted that, in emerging markets, sophisticated tools do not lead to the same amount of benefits as compared to in mature markets owing to shortages of specialists in data analytics.

In our study, S&OP Culture has the weakest unstandardised regression weight (though significant with p=0.018) in improving Supply Chain Performance. Yet, our examination of respondents' comments points to a lack of management support, organisational buy-in and change management as common recurring themes among respondents who experienced disappointing improvement improvements in Supply Chain Performance from implementing S&OP.

Given the strong S&OP culture-performance link in the literature (e.g. Grimson and Pyke, 2007; Thomé et al., 2012a; Tuomikangas and Kaipia, 2014), our results are intriguing in that the level of significance of the culture-performance effect was not more pronounced. A plausible reason may be that S&OP Culture acts as a kind of precursor or antecedent mechanism and that intervening factors/mechanisms are involved between the S&OP Culture mechanism and Supply Chain Performance. This needs further investigation research but lies beyond our scope for this current study.

The literature points to two key intertwining factors that may help explain why the S&OP Organisation mechanism is not broadly associated with Supply Chain Performance improvements across the moderators studied. First, S&OP usually requires local support, even when S&OP implementations are regional or global in nature. Yet, a myriad of regional/global stakeholders can make coordination difficult in practice (Pedroso et al., 2016). Second, firms may occasionally respond to such difficulties by emphasising hierarchies instead of roles and responsibilities, which may increase decision-making efficiency but decrease its effectiveness (Lawrence and Lorsch, 1967b; Grant, 1996; Heath and Staudenmayer, 2000). However, it appears from our results that firms generally learn to overcome this challenge with greater S&OP experience (p=0.104). Hence, while organisations with "young" S&OP programmes may experience "growing pains" (such as investing in building S&OP teams but not seeing the results initially), these efforts and investments may pay off in the medium to long run (Boyer, 2009).

On the other hand, the Performance Management mechanism was not significantly linked to superior Supply Chain Performance in our study and this was largely independent of the moderators studied. In other words, the positive effect of "direct supervision" or "tracking" of interdependent tasks (Malone and Crowston, 1994) in

coordination theory does not apparently extend to S&OP. Comments provided by our respondents suggest that this may be because performance metrics have not always been acted upon constructively nor are they widely socialised within the organisation. This is reminiscent of the findings from Cousins et al. (2008) who conclude (in the context of buyer-supplier relationships) that monitoring performance is not in itself sufficient, but rather it is the process of *socialising* that is critical to success. Moreover, that the Performance Management mechanism is significant only in Asia-Pacific is suggestive of a supervision-based approach towards S&OP, whereby the old adage that "what gets measured gets done" may be more embedded in the workplace.

Another key finding from this study is that a highly formalised procedure/schedule very significantly ($p<0.001$) dampens (rather than amplifies) Supply Chain Performance. This dampening effect is generally present regardless of the contingency environments that we have studied but is especially apparent in large companies ($p=0.040$) and to a less significant extent those companies with high S&OP experience ($p=0.210$). Furthermore, this negative relationship exists in our dataset even if S&OPs implementations are nominally "mature" as indicated by the strengths of the other five coordinating mechanisms. Written policies, rules, job descriptions, standard procedures, deadlines, guidelines and specifications (Martinez and Jarillo, 1989; Montoya-Weiss et al., 2001) can coordinate teams. However, more successful S&OP programmes are more likely to be those that convene S&OP meetings whenever they are needed and use bespoke processes according to the situation at hand, particularly after the organisation has gained more than five years' experience in S&OP.

5.6.2. Bricolage as a coordinating mechanism in S&OP

Our finding on the inverse effect of standardised procedures/schedules on S&OP outcomes is contradictory to the extant *practitioner* literature, which was not expected at the outset of our study, but is not entirely surprising in hindsight. Pinto et al. (1993) suggest that "as an organisation's design becomes increasingly complex…the effectiveness of rules as a coordinating device among departments decreases". In more unstable and uncertain environments, effective organisations are usually those that are less formalised and more reliant on mutual adjustment (Lawrence and Lorsch, 1967b). From the S&OP perspective, mature firms that practise a more responsive, "event-driven" form of S&OP have been better able to react to rapid changes in the market place, cope with evolving business needs and deal with exceptions (Grimson and Pyke, 2007). Furthermore, in a simulation study of the coupling of sales targets and operational capacity in IT-enabled service supply chains, Akkermans et al. (2016) found that a loosely-coupled regime (in which sales and operations retain their own independent but agile control loops) performs better than when the regime is tightly-coupled. These, when interpreted in conjunction with our results, strongly suggest that rather than being set in stone, S&OP and its processes should be adjusted to the planning environment or situation (Ivert et al., 2015; Kaipia et al., 2017).

Evidence from our study and others therefore suggests that among experienced S&OP teams, organisational bricolage (in particular reorganising routines and reordering) may be a coordinating mechanism of effective S&OP programmes, as shown in Figure 5-3. In conceptualising bricolage as a coordinating mechanism, an analogy can be made between high-performing teams in S&OP and high-performing teams in a battlefield. While winning battles require rebalancing reactions to unexpected enemy manoeuvres, S&OP teams need to constantly rebalance unexpected flux in demand or supply. Both

types of teams must process and react quickly to unanticipated events that spontaneously deviate from "common and valued", via a *self-governed change* in team coordination (Gorman et al., 2007) and/or a reorganisation of routines (Bechky and Okhuysen, 2011).

In the context of S&OP, bricolage may take the form of ambidextrous multi-disciplinary team leaders who are empowered to convene S&OP meetings at short notice and to circumvent organisational protocols on decision-making should the need arise. Controls on prescribed S&OP procedures and formats of S&OP meetings can be "simultaneously tight and loose" (Tushman and O'Reilly, 1996), such that individuals in S&OP teams are entrusted to make their own judgments to meet conflicting demands for alignment and adaptability (Gibson and Birkinshaw, 2004) via agile pre-emptive adjustments to the S&OP plan and flexible meeting formats in a dynamic operating environment. To the uninitiated, such a process might border on a state of "chaos" (to borrow the term from one survey respondent). However, if implemented well, what would then prevent the S&OP programme from actually devolving from "coordinated chaos" into genuine chaos would be the operative efficacious S&OP coordination mechanisms, namely Strategic Alignment, Information Acquisition/Processing, S&OP Organisation and S&OP Culture.

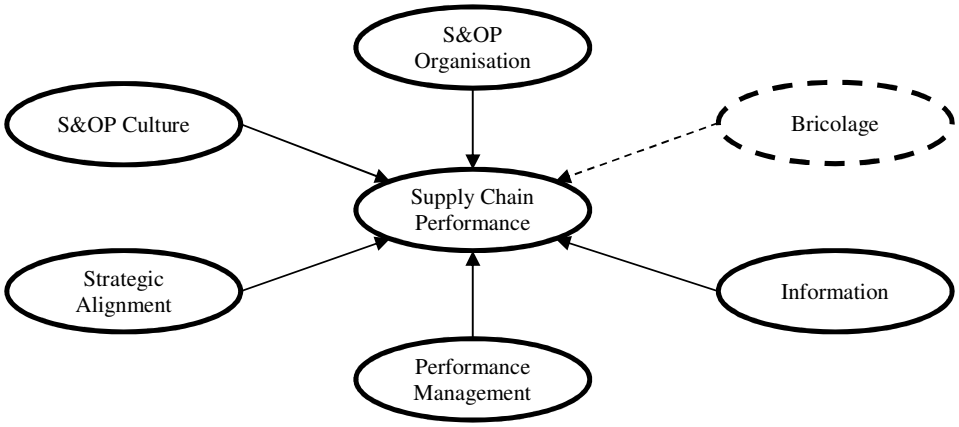


Figure 5-3: Bricolage as a Coordinating Mechanism in Mature S&OP Programmes

Yet, this is not to say that procedures or schedules have no place in S&OP programmes. While there may be value in enforcing rules-based procedures for dysfunctional organisations in which asynchronous actions and functional silos are prevalent, well-functioning firms with experienced teams that face great market uncertainties would be better poised to achieve rebalance using self-governing event-driven processes and ambidextrous teams (Tushman and O'Reilly, 1996; Benner and Tushman, 2003; Gibson and Birkinshaw, 2004). This points to a trade-off between closely-integrated versus ambidextrous forms of S&OP, such that when uncertainties are high, agility in S&OP is necessary and tightly-aligned S&OP processes might be counterproductive (Ivert et al., 2015; Akkermans et al., 2016; Kaipia et al., 2017). This important finding may trigger a re-evaluation of the efficacy of prescriptive S&OP procedures that have been advocated by some researchers and practitioners such as Lapide (2004a), Boyer (2009), Milliken (2008), Smith et al. (2010) and Swaim et al. (2016).

5.7. Conclusion

S&OP as a process has been established in the industry for decades and is well-known to practitioners, thanks to advocacy by organisations such as APICS. Our study is the first large-scale survey of its kind that is specifically focused on S&OP using a rigorous theoretical framework built upon coordination theory and targeted at respondents who are S&OP experts and practitioners from a cross-section of industries and geographies. Beyond establishing the strength of relations between S&OP coordinating mechanisms and Supply Chain Performance, this study has uncovered compelling empirical evidence on the negative relationship between S&OP Procedure/Schedule and Supply Chain Performance. This link that has been alluded to in Grimson and Pyke (2007) and some recent coordination literature (e.g. Bechky and Okhuysen, 2011; Jarzabkowski et al., 2012), but is generally overlooked in the S&OP practitioner literature. We therefore propose organisational bricolage as a coordinating mechanism that can help experienced S&OP teams achieve better supply chain performance. We have also established a set of scales for S&OP coordination mechanisms that have been shown to fit well on a large global sample across multiple industries.

A contingent implication from our study is for managers who are extending their S&OP programmes from Europe and the Americas to Asia. While these managers may be accustomed to seeing strong S&OP outcomes from a strong organisational culture in their home markets, a strong Performance Management mechanism in the Asia-Pacific is more likely to result in greater improvements to Supply Chain Performance from S&OP. Another implication of our results pertains to managers who are translating their S&OP implementation expertise across industries, which might see different results from S&OP (Thomé et al., 2014a). For example, our research suggests that in the automotive/industrial products industry cluster, managers should focus on building a

formal S&OP Organisation, but this is less important in the consumer/technology and food products industry clusters. Additionally, as much as managers may be tempted to use "plug-and-play" S&OP Procedures based upon established meeting templates, our results suggest that beyond setting a few simple ground rules initially, managers should allow the S&OP Procedure to evolve as it matures and improvise in the face of demand/supply uncertainties.

This study has several limitations. First, the significance of paths is based only on the total effects between the individual coordinating mechanisms (constructs) and Supply Chain Performance. Mediating effects (such as that between S&OP Culture and Supply Chain Performance in the structural model) are not explored but could potentially yield more insights via a separate multi-mediator model. Second, external integration with customers or suppliers (e.g. channel coordination between manufacturers and retailers) has been shown to enhance the impact of S&OP in at least one instance (Goh and Eldridge, 2015) but this effect has not been studied in this paper. Third, we have proposed bricolage as a coordinating mechanism for mature S&OP programmes, but the specific dynamics of role shifting, reorganising routines and reordering in S&OP would need to be more thoroughly investigated. Similarly, the investigation of the dynamic decision rules for whether products should be included into an S&OP portfolio is not within the scope of our study. Fourth, this study has not imposed a minimum level of coordinating mechanisms within organisations implementing S&OP and hence our survey sample includes a small minority of apparently "poor" specimens of S&OP programmes. Nonetheless, these could potentially be the focus of a separate study on why such organisations face challenges in converting concepts of S&OP into practice, despite its formal adoption at these organisations.

Our study has focused on the elaboration and extension of existing knowledge of the linkages between S&OP implementation and Supply Chain Performance. Having established these relationships using a cross-sectional study, our findings pave the way for further research to understand how and why these relationships develop in individual organisations. Given the strong culture-performance link found in the literature, the weaker than expected link between S&OP Culture and Supply Chain Performance in organisations practicing S&OP is deserving of further study. Finally, the notion of a superior form of a responsive, self-governing S&OP programme that breaks away from the straitjacket of a formalised and standardised process holds great promise for future research.

5.8. Appendix A: Survey Questions as Administered to Respondents

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Q1 **Global Study on Sales & Operations Planning**

This survey is part of a research project at Lancaster University on Sales & Operations Planning (S&OP).

APICS defines S&OP as "a process to develop tactical plans that brings together all the plans for the business (sales, marketing, development, manufacturing, sourcing, and financial) into one integrated set of plans".

This survey aims to investigate the impact of S&OP on supply chain performance, from the perspective of experienced S&OP practitioners worldwide.

All information collected is on a "no-name" basis. You and your company will remain anonymous. Results will only be reported on an aggregated level.

Enquiries on the study can be sent to s.goh4@lancaster.ac.uk.

Thank you.

Q2 In which ***country or territory*** are you currently based?

▼ Afghanistan ... Zimbabwe

Q3 Please select the ***industry*** that best describes the sector that your organisation operates in. (If you are an external consultant in S&OP, please answer this survey from the perspective of your most recent client).

- ○ Aerospace and Defense Equipment
- ○ Apparel, Footwear and Textiles
- ○ Agriculture and Agribusiness
- ○ Automotive
- ○ Beverages
- ○ Energy and Chemicals
- ○ Food Products
- ○ High-Tech and Consumer Electronics
- ○ Household and Personal-Care Products
- ○ Industrial Equipment
- ○ Life Science and Healthcare Products
- ○ Mining
- ○ Public Sector or Non-Profit
- ○ Retail and Distribution (Multi-Products)
- ○ Other

Q4 Your organisation is ***globally headquartered*** in

- ○ Asia Pacific
- ○ Europe
- ○ Latin America
- ○ Middle-East / Africa
- ○ USA / Canada

Q5 How many ***employees*** does your organisation have globally?

- ○ 50,000 and above
- ○ 10,000 to 49,999
- ○ 5,000 to 9,999
- ○ 1,000 to 4,999
- ○ 500 to 999
- ○ 100 to 499
- ○ 50 to 99
- ○ 1 to 49

Q6 Your ***functional role*** in the organisation can be best described as:

- ○ Sales or account management
- ○ Manufacturing and operations management
- ○ Procurement / purchasing / supply management
- ○ Demand planning
- ○ Logistics management
- ○ Finance
- ○ Product development
- ○ After-sales management
- ○ General management
- ○ Other

Q7 ***Is your business unit using any S&OP processes?*** Business unit refers to the lowest level distinct entity that you work for (rather than the parent or group entity).

- ○ Yes, formal S&OP has been established for more than 10 years
- ○ Yes, formal S&OP has been established for more than 5 to 10 years
- ○ Yes, formal S&OP has been established for more than 2 to 5 years
- ○ Yes, formal S&OP has been established recently in the past 2 years
- ○ Yes, some form of collaborative forecasting (informal S&OP) exists, but there is no formal S&OP process
- ○ No, S&OP is not implemented or applicable at my organisation

Q8 The ***number of daily orders*** (i.e. not the number of physical units) fulfilled by your business unit can be characterised as:

- ○ Very high (500 orders or more a day)
- ○ High (200 to 499 orders a day)
- ○ Medium (50 to 199 orders a day)
- ○ Low (10 to 49 orders a day)
- ○ Very low (<10 orders a day)

Q9 Your business unit's ***product variety*** can be characterised as:

- ○ Very high (>5,000 active SKUs)
- ○ High (2,000 to 5,000 SKUs)
- ○ Medium (500 to 1,999 SKUs)
- ○ Low (100 to 499 SKUs)
- ○ Very low(<100 SKUs)

Q10 Your business unit's typical ***product lifecycle*** (from introduction to withdrawal from sale) can be characterised as:

- ○ Very short (1 year or less)
- ○ Short (>1 to 2 years)
- ○ Medium (>2 to 5 years)
- ○ Long (>5 to 10 years)
- ○ Very long (>10 years)

Q11 Please indicate the extent to which you agree that ***S&OP has brought about the following benefits at your business unit***.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Increased forecast accuracy	○	○	○	○	○	○	○
Reduced lead time to customers	○	○	○	○	○	○	○
Reduced stock-outs or back-orders	○	○	○	○	○	○	○
Reduced inventory	○	○	○	○	○	○	○
Increased responsiveness to changes in demand	○	○	○	○	○	○	○
Increased responsiveness to disruptions in supply	○	○	○	○	○	○	○

Q12 Which **departments are regularly involved in S&OP** in your business unit?

	Always involved	Often involved	Occasionally involved	Seldom involved	Totally uninvolved
Sales or account management	○	○	○	○	○
Manufacturing	○	○	○	○	○
Procurement	○	○	○	○	○
Logistics	○	○	○	○	○
Finance	○	○	○	○	○
Product development	○	○	○	○	○
Suppliers	○	○	○	○	○
Customers	○	○	○	○	○
Logistics services providers	○	○	○	○	○
Company management (e.g. CEO, CFO, MD)	○	○	○	○	○

Q13 [Optional] Please include any comments you may have related to S&OP benefits or departmental involvement.

_____
_____
_____

Q14 This question-set deals with ***S&OP Organisation***. Please indicate the extent to which you agree with the following statements, ***in the context of your business unit***.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
There is a formal team involved in S&OP meetings	○	○	○	○	○	○	○
There is a designated owner(s) for the S&OP process	○	○	○	○	○	○	○
All key internal stakeholders in the organisation are represented in S&OP meetings	○	○	○	○	○	○	○
Each participant in S&OP meetings has clear roles and responsibilities	○	○	○	○	○	○	○
The S&OP team is responsible for setting decisions that are made centrally on behalf of the organisation	○	○	○	○	○	○	○

Q15 This question-set deals with ***S&OP Processes***. Please indicate the extent to which you agree with the following statements, ***in the context of your business unit.***

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
S&OP meetings or conference calls are conducted at least once a month	○	○	○	○	○	○	○
There is a defined common S&OP calendar within the company, as part of the S&OP process	○	○	○	○	○	○	○
S&OP meetings or conference calls follow a standard process/format	○	○	○	○	○	○	○
There are written guidelines or manuals on the S&OP process	○	○	○	○	○	○	○
Sub-plans are shared and discussed among participants, as part of the S&OP process	○	○	○	○	○	○	○
The S&OP process creates one set of consensus forecasts relied upon by all departments	○	○	○	○	○	○	○

Q16 This question-set deals with ***Tools & Data***. Please indicate the extent to which you agree with the following statements, ***in the context of your business unit***.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
S&OP data requirements are well-defined	○	○	○	○	○	○	○
S&OP data collected is of a high standard	○	○	○	○	○	○	○
S&OP is enabled by IT tools that are used in creating operational plans	○	○	○	○	○	○	○
It is easy to share, retrieve or update S&OP-related data within the organisation	○	○	○	○	○	○	○
External data from suppliers is available and relied upon in S&OP	○	○	○	○	○	○	○
External data from customers is available and relied upon in S&OP	○	○	○	○	○	○	○

Q17 [Optional] Please include any comments you may have related to S&OP organisation, processes or tools & data.

_____
_____
_____
_____

Q18 This question-set deals with ***Performance Management***. Please indicate the extent to which you agree with the following statements, ***in the context of your business unit***.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Targets derived using the S&OP process is tracked against actual performance	○	○	○	○	○	○	○
Performance issues and bottlenecks are effectively addressed and followed-up upon after S&OP meetings	○	○	○	○	○	○	○
S&OP performance metrics have multiple dimensions from the financial, operations or process perspectives	○	○	○	○	○	○	○
S&OP performance metrics are regularly shared with supply chain partners	○	○	○	○	○	○	○
S&OP performance metrics balance between the interests of various parties in the organisation	○	○	○	○	○	○	○

Q19 This question-set deals with ***Strategic Alignment***. Please indicate the extent to which you agree with the following statements, ***in the context of your business unit***.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Top-down strategic targets and S&OP consensus decisions are aligned with each other	○	○	○	○	○	○	○
S&OP effectively links capacity levels and production levels	○	○	○	○	○	○	○
S&OP supports the company in achieving its strategic targets	○	○	○	○	○	○	○
S&OP supports the coordination of new product introductions	○	○	○	○	○	○	○
S&OP supports the entering of new markets or on-boarding of new customers	○	○	○	○	○	○	○
There is two-way feedback between strategic plans and S&OP plans	○	○	○	○	○	○	○

Q20 This question-set deals with the ***Culture & Leadership***. Please indicate the extent to which you agree with the following statements, ***in the context of your business unit***.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
S&OP is effective in fostering a collaborative company culture	○	○	○	○	○	○	○
S&OP is effective in promoting dialogue to resolve inter-department conflicts	○	○	○	○	○	○	○
Top management is supportive of S&OP	○	○	○	○	○	○	○
Employees are empowered to contribute actively to the company's plans at various levels	○	○	○	○	○	○	○
There is trust among employees or departments within the company	○	○	○	○	○	○	○
There is effective communications of business objectives and vision within the company	○	○	○	○	○	○	○

Q21 [Optional] Please include any comments you may have related to S&OP performance management, strategic alignment or culture & leadership.

_____
_____
_____

5.9. Appendix B: Constructs, Measurement Items, Descriptive Statistics and Factor Loadings

Construct	Measurement Item	Selected Supporting Literature	Mean	Standard Deviation	Standardised Loading	Critical Ratio #
Supply Chain Performance	S&OP has brought about reduced lead time to customers at your business unit	Collin & Lorenzin (2006); Nakano (2009); Goh & Eldridge, (2015)	2.18	1.12	0.75	a
	S&OP has brought about reduced stock-outs or back-orders at your business unit	Schrieber (2005); Wallace (2006); Chase (2013)	2.27	1.15	0.77	14.76
	S&OP has brought about reduced inventory at your business unit	Muzumdar & Fontanella (2006); Boyer (2009); Lapide (2004b); Goh & Eldridge, (2015)	2.31	1.17	0.66	11.86
	S&OP has brought about increased responsiveness to changes in demand at your business unit	Ling & Goddard (1988); Harwell (2006); Bower (2012b); Hadaya & Cassivi (2007); Mello & Stahl (2011); Chase (2013)	2.22	1.10	0.68	11.49
	S&OP has brought about increased responsiveness to disruptions in supply at your business unit	Schrieber (2005); Smith et al. (2010); Ivert & Jonsson (2010)	2.72	1.27	0.68	10.11
S&OP Organisation	There is a formal team involved in S&OP meetings	Ling & Goddard (1988); Lapide (2004a); Grimson & Pyke (2007); Swaim et al. (2016); Pedroso et al. (2016)	1.46	0.80	0.65	a
	There is a designated owner(s) for the S&OP process	Grimson & Pyke (2007); Iyangar & Gupta (2013); Wagner et al. (2014); Tuomikangas & Kaipia (2014)	1.42	0.80	0.77	11.86
	Each participant in S&OP meetings has clear roles and responsibilities	Lapide (2004a); Lapide (2007) Wagner et al. (2014); Tuomikangas & Kaipia (2014)	1.99	1.03	0.83	12.44

Construct	Measurement Item	Selected Supporting Literature	Mean	Standard Deviation	Standardised Loading	Critical Ratio #
S&OP Procedure/ Schedule ("Procedure")	There is a defined common S&OP calendar within the company, as part of the S&OP process	Lapide (2004a); Bower (2005); Boyer (2009); Milliken (2008); Smith et al. (2010); Tuomikangas & Kaipia (2014); Alexander (2016)	1.40	0.76	0.78	a
	S&OP meetings or conference calls follow a standard process/format	Lapide (2004a); Bower (2005); Ivert & Jonsson (2010), Oliva & Watson (2011); Thomé et al. (2012a); Tuomikangas & Kaipia (2014); Swaim et al. (2016); Ambrose & Rutherford (2016)	1.62	0.85	0.81	14.43
	S&OP meetings or conference calls are conducted at least once a month	Ling & Goddard (1988); Lapide (2004a); Grimson & Pyke (2007); Smith et al. (2010); Alexander (2016)	1.38	0.84	0.53	10.16
Information Acquisition/ Processing ("Information")	It is easy to share, retrieve or update S&OP-related data within the organisation	Grimson & Pyke (2007); Milliken (2008); Tuomikangas & Kaipia (2014); Kaipia et al. (2017)	2.86	1.44	0.68	a
	S&OP is enabled by IT tools that are used in creating operational plans	Lapide (2004a); Lapide (2004b); Grimson & Pyke (2007); Affonso et al. (2008); Ivert & Jonsson (2010)	2.90	1.53	0.55	14.16
	S&OP data collected is of a high standard	Ling & Goddard (1988); Grimson & Pyke (2007); Ivert & Jonsson (2010); Tuomikangas & Kaipia (2014); Ambrose & Rutherford (2016)	2.45	1.19	0.82	15.23
	S&OP data requirements are well-defined	Ling & Goddard (1988); Schrieber (2005); Stahl (2010); Tuomikangas & Kaipia (2014); Ambrose & Rutherford (2016)	2.07	1.04	0.81	15.70

Construct	Measurement Item	Selected Supporting Literature	Mean	Standard Deviation	Standardised Loading	Critical Ratio #
Performance Management	S&OP performance metrics have multiple dimensions from the financial, operations or process perspectives	Ling & Goddard (1988); Grimson & Pyke (2007); Milliken (2008); Iyangar & Gupta (2013); Tuomikangas & Kaipia (2014)	2.24	1.20	0.66	a
	Targets derived using the S&OP process is tracked against actual performance	Ling & Goddard (1988); Lapide (2004a); Bower (2005); Thomé et al. (2012a); Milliken (2013); Wagner et al. (2014)	1.90	1.02	0.71	13.93
	S&OP performance metrics balance between the interests of various parties in the organisation	Grimson & Pyke (2007); Stank et al. (2011); Thomé et al. (2012b); Tuomikangas & Kaipia (2014)	2.40	1.19	0.84	14.38
	Performance issues and bottlenecks are effectively addressed and followed-up upon after S&OP meetings	Bower (2005); Milliken (2008); Tuomikangas & Kaipia (2014); Van Hove (2016)	2.17	1.01	0.80	15.02
Strategic Alignment	S&OP supports the entering of new markets or on-boarding of new customers	Muzumdar & Fontanella (2006); Mello & Esper (2007); Tuomikangas & Kaipia (2014)	2.79	1.44	0.69	a
	S&OP supports the coordination of new product introductions	Olhager et al. (2001); Wallace (2006); Tuomikangas & Kaipia (2014); Goh & Eldridge (2015)	2.41	1.27	0.68	16.84
	There is two-way feedback between strategic plans and S&OP plans	Lapide (2011); Tuomikangas & Kaipia (2014); Van Hove (2016)	2.60	1.26	0.79	14.20
S&OP Culture	There is trust among employees or departments within the company	Hadaya & Cassivi (2007); Mello (2010); Oliva & Watson (2011); Thomé et al. (2012a); Tuomikangas & Kaipia (2014)	2.63	1.27	0.84	a
	Employees are empowered to contribute actively to the company's plans at various levels	Ling & Goddard (1988); Lapide (2004a); Lapide (2005); Muzumdar & Fontanella (2006); Oliva & Watson (2011); Thomé et al. (2012a); Tuomikangas & Kaipia (2014); Wagner et al. (2014)	2.46	1.24	0.79	18.46
	There is effective communications of business objectives and vision within the company	Godsell et al. (2010); Tuomikangas & Kaipia (2014); Van Hove (2012 & 2016)	2.41	1.24	0.88	21.02
	Top management is supportive of S&OP	Grimson & Pyke (2007); Thomé et al. (2012a); Tuomikangas & Kaipia (2014); Van Hove (2012)	1.84	1.17	0.78	14.51

Note: ‘‘a’’ means that the regression weight was fixed at 1.00, not estimated. N = 568

Chapter 6 – Sales & Operations Planning: The Mediating Effects Between S&OP Culture and Supply Chain Performance

This chapter is adapted from an unpublished manuscript that is ready to be submitted to a journal. An early version of this research was presented at the 24th EurOMA Conference in 2017. This manuscript is authored by Shao Hung Goh and Stephen Eldridge. Both authors contributed to the study design and manuscript preparation. Data collection and primary analysis were conducted by the first author. Adjustments have been made to the original manuscript (such as in the numbering of sections, figures and tables) to improve the coherence with other parts of this thesis.

Abstract

This paper investigates mediation in Sales and Operations Planning (S&OP) and the role of organisational culture as an antecedent of superior S&OP outcomes. By viewing S&OP coordination mechanisms as an S&OP team's internal means of coping collectively with challenges to be resolved in a supply chain, five S&OP coordination mechanisms were hypothesised to act as mediators between "S&OP Culture" and Supply Chain Performance in a multiple mediator model. Results from a global survey of S&OP practitioners provide evidence of what we call the "strong-culture conundrum". While a strong S&OP culture leads to better overall coordination outcomes, the former's effects are primarily transmitted indirectly through the Strategic

Alignment and Information Acquisition/Processing coordination mechanisms. Yet, a strong S&OP culture may concurrently suppress Supply Chain Performance via the S&OP Procedure/Schedule pathway due to competitive mediation. These results suggest that organisations implementing S&OP can benefit from a culture of contextual ambidexterity by allowing S&OP teams to make their own judgments to strike a balance between alignment and adaptability. This study contributes to the literature at the interface of Organisation Science and Operations Management by presenting a model of S&OP Culture as an antecedent of effective S&OP programmes.

Keywords: S&OP, Organisational Culture, Coordination Mechanisms, Mediation, Ambidexterity

6.1. Introduction

The foundations of Sales and Operations Planning (S&OP) comprise a set of business processes and technologies that enable an enterprise to respond effectively to demand and supply variability (Muzumdar and Fontanella, 2006). Its deployment illustrates a form of internal collaboration in which a cross-functional team reaches consensus (Slone et al., 2013), with insight into the optimal market deployment and most profitable supply chain mix. S&OP is thus an important topic in organisational coordination and the wider context of supply chain integration.

The reported benefits of S&OP are numerous and include: higher customer satisfaction; lower and more balanced inventory; lower lead times; more stable production rates; more cooperation across the entire operation; better forecasting; more efficient decision

making; and a greater focus on the long-term horizon (Thomé et al., 2012a; Tuomikangas and Kaipia, 2014; Goh and Eldridge, 2015 [Chapter 4 of this thesis]; Kaipia et al., 2017; Noroozi and Wikner, 2017). However, not all enterprises have benefited to the same extent by implementing S&OP. Some researchers (e.g., Mello, 2010; Pedroso, 2016) partially attribute this to the presence of a "silo culture" in those enterprises, which reflects Fawcett and Magnan (2002)'s observation of a "chasm" that divides the purchasing and marketing functions in many organisations. This apparent divide is often embedded in the enterprise's organisational structures and culture and has prompted studies into the effect of organisational culture on firm performance by strategy and marketing researchers but there are relatively few examples in the field of operations management (McDermott and Stock, 1999; Nahm et al., 2004; Mello and Stank, 2005; Braunscheidel et al., 2010). There is also a need for greater understanding of how cultural, strategic and implementation elements in a supply chain interrelate with each other (Barratt, 2004). In the context of S&OP, our understanding of the effects of organisational culture on supply chain performance and the pathways through which cultural influences are exerted is relatively limited despite its relevance to the realisation of the benefits of S&OP.

Culture is but one of several S&OP coordinating mechanisms identified in earlier studies. Our study aims to investigate how the link between S&OP culture and supply chain performance may be mediated by these other mechanisms and considers the role of culture as an antecedent to effective S&OP implementations.

6.2. Theoretical Background and Literature Review

Organisational culture is a fundamental trait that differentiates organisations and determines how interconnected they are both internally and externally. As such, we begin by providing some definitions and a typology of organisational culture prior to discussing the links between organisational culture and firm performance. The role of culture in S&OP and in supply chain integration will then be explored.

6.2.1. Definitions and typology of organisational culture

Organisational culture can be described as "a complex set of values, beliefs, assumptions, and symbols that define the way in which a firm conducts its business" (Barney, 1986b). Schein (1990) proposes six defining features of an organisational culture, namely: 1) A pattern of basic assumptions, 2) invented, discovered, or developed by a given group, 3) as it learns to cope with its problems of external adaptation and internal integration, 4) that has worked well enough to be considered valid and, therefore 5) is to be taught to new members as the 6) correct way to perceive, think, and feel in relation to those problems. For example, when an organisation faces problems of external adaptation and survival, organisational culture helps determine how the group collectively copes internally with the situation in a problem-solving cycle, based on developing consensus on strategy, goals, means for accomplishing goals, measuring performance and correction (Schein, 1984). Furthermore, subcultures can coexist in an organisation (Saffold, 1988; Schein, 1990; Denison and Mishra, 1995), such as those related to work units or occupations (e.g. a safety subculture for pilots and drivers). Moreover, subcultures, if properly managed and connected to the parent culture, can be an important source of potential innovation (Schein, 1990).

Organisational culture can also be characterised by an organisation's underlying traits and value dimensions (Denison and Mishra, 1995), which are widely shared and strongly held within the organisation (Braunscheidel et al., 2010). Attempts have been made to draw parallels with the psychological archetypes of individuals and classify organisational cultures into distinct categories. For example, Cameron and Quinn (1999) propose a Jungian framework for organisational culture types and describe four distinct types: clan, hierarchy, adhocracy, and market.

However, other researchers suggest organisational cultural traits need not be mutually exclusive nor conform to idealised profiles or archetypes. For example, Tushman and O'Reilly (1996) present a theory of organisational ambidexterity in which ambidextrous organisations are those capable of implementing both evolutionary (i.e., incremental) and revolutionary change. They suggest that superior performance can be expected from ambidextrous organisations that have cultures that have "simultaneously tight and loose" social controls. While the concept of ambidexterity was conceived to address the trade-off between efficiency and innovation in manufacturing, Blome et al. (2013) extend ambidexterity to the domain of supply chain management and define ambidexterity generally as the simultaneous pursuit of both relational and contractual governance elements in buyer-supplier relationships. They found that demand uncertainty and product complexity are important contextual variables in the moderating effects of organisational ambidexterity on cost and innovation performance.

6.2.2. Organisational culture and the link to firm performance

Despite the difficulties in classifying organisational culture, there have been numerous studies that link the intensity of organisational culture to firm performance. For example, Kotter and Heskett (1992) found that firms perceived to have a strong

corporate culture generally have higher average levels of return on investment, net income growth and changes in share price. Similarly, Gordon and DiTomaso (1992) found that a strong culture, irrespective of content, that places a substantive value on adaptability is associated with better firm performance in the short-term. Denison and Mishra (1995) also found that each of the cultural traits of involvement, consistency, adaptability, and mission show significant positive association with a wide range of both subjective and objective measures of organisational effectiveness.

Empirical evidence of the influence of organisational culture in the manufacturing context can be found in several cross-sectional surveys. For example, Bates et al. (1995) found that, in the US, manufacturers with a well-aligned and implemented manufacturing strategy exhibit a collectivist or group-oriented organisational culture with coordinated decision making, decentralised authority, and a loyal workforce. McDermott and Stock (1999) similarly found significant links between organisational culture and outcomes of advanced manufacturing technology implementation. Likewise, Nahm et al. (2004) found that those firms who embrace a customer orientation culture have more integrative beliefs and higher levels of time-based manufacturing practices which lead to higher levels of performance.

Within the supply chain context, Mentzer et al. (2001) consider several elements of organisational culture (including trust, commitment, vision and top management support) as antecedents to a firm's supply chain orientation. They describe supply chain orientation as the recognition by an organisation of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain. Furthermore, Eng (2006) found that organisational norms (particularly intra-organisational knowledge sharing and a participative culture) play important roles in supporting cross-functional coordination and, consequently, supply chain

responsiveness. Structural coordinating mechanisms may facilitate cross-functional coordination but the absence of management expectations and values for cross-functional coordination can have a negative effect on supply chain responsiveness (Eng, 2006).

However, Saffold (1988) highlights that the relationship between culture and performance is not necessarily monotonic. For example, if cultural controls multiply too greatly, resistance is likely to develop leading to a decrease in performance. It is also possible that a particular cultural trait or feature may not affect all performance-related organisational processes in the same direction (Saffold, 1988). Furthermore, a "cultural inertia" may result and eventually lead to failure (Tushman and O'Reilly, 1996) in organisations that have been successful in earlier developments of interlinked structures and systems to handle work complexity.

An additional problem with attempting to link organisational culture to firm performance is that the former does not necessarily directly cause the latter and there may be other intervening factors involved. Fiol (1991) indicates that the cognitive component of organisational competency focuses on how people make sense of particular skills and assets and how they use them to transform them into outcomes. These cognitive processes thus act as a link between beliefs and behaviours, provided a conducive environment exists. Sørensen (2002) found that, in relatively stable environments, firms exhibiting a strong culture have greater goal alignment, superior coordination and control, and higher motivation levels. This leads to more reliable (less variable) performance. However, in more volatile environments, the reliability benefits of a strong culture disappear.

6.2.3. Organisational culture and supply chain integration

The role of organisational culture may extend beyond the individual firm by exerting influence in the firm's upstream and downstream supply chain. In its most advanced form, supply chain management can be regarded as a cultural orientation or philosophy that guides supply chain decision making and is enabled by can be described as supply chain integration (Fawcett and Magnan, 2002). Supply chain integration can be described as the degree to which a manufacturer strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organisation processes (Flynn et al, 2010). Barratt (2004) presents a "collaborative culture" (defined by trust, mutuality, information exchange and openness/communication) that is a pre-requisite for effective process alignment, joint decision making and supply chain metrics. These descriptions explicitly highlight the influence of aspects of organisational culture on supply chains.

Following an analysis of studies of the marketing/operations interface and supported by interviews with companies across a range of industry sectors, Pagell (2004) proposes a model of internal supply chain integration in which organisational culture and organisational structure are important antecedents to internal supply chain integration. For example, companies with mechanised structures and cultures that are very functionally orientated tend to both discourage communication across functions and encourage measures reflecting the optimisation of local rather global performance, which together lead to a lower level of internal integration and performance. Similarly, the supply chain cultural orientation framework of Mello and Stank (2005) also proposes that shared values assumptions predicate shared values, which in turn govern the integrative behaviours of the firm and its partners, and ultimately drive effective supply chain management.

In a survey study of 218 respondents using a competing values framework, Braunscheidel et al. (2010) investigated the effects of four dimensions of organisational culture (market, hierarchy, clan, and adhocracy) on internal and external supply chain integration. Their results indicate that a firm's adhocracy culture (characterised by adaptability and innovation) is positively associated with external integration, while a firm's hierarchy culture (which emphasises order, rules and regulations, clear lines of authority, uniformity and efficiency) is negatively associated with both internal and external integration practices. These findings are also generally in agreement with those of Cao et al. (2015) who surveyed 317 manufacturers across ten countries and found that a firm profile with high levels of development, group and rational cultures and a low level of hierarchical culture would achieve the highest levels of internal, customer and supplier integration.

6.2.4. Culture as an antecedent in S&OP

In the context of S&OP, Tuomikangas and Kaipia (2014) identify several elements of an organisation's culture (which include commitment, trust, top management setting an example, collaboration and empowerment) that coordinate the S&OP process. Ambrose et al. (2018) similarly found that decision-making latitude, joint rewards, information quality and availability of resources can all help foster S&OP team social identity. Swaim et al. (2016), in a study of North American S&OP practitioners, conclude that "organisational integration positively influences a standardised S&OP process, and both the S&OP process and prioritisation lead to stronger organisational S&OP engagement", which in turn increases S&OP effectiveness. Furthermore, Qi and Ellinger (2017) propose a framework of complementary organisational orientations (service orientation, internal market orientation, financial orientation, and supply chain

orientation) that collectively promote organisational culture and enable S&OP. Practitioners (e.g. Mello, 2010; Mello and Stahl, 2011; Van Hove, 2012) also emphasise the importance of company culture on S&OP effectiveness, whereby a successful execution requires collaboration, trust, openness and an environment in which departments and individuals accept responsibility.

The literature examines in some detail the various components of "mature" S&OP implementations (e.g. Grimson and Pyke, 2007), yet does not study the mediating effects between individual coordinating mechanisms. It would be most peculiar if coordinating mechanisms are mutually exclusive or are completely unrelated to each other.

An associated observation from the S&OP literature is that the use of mediation techniques is rather uncommon. A notable study by Oliva and Watson (2011) qualitatively explored the mediating role of "process specifications" (comprising information quality, procedural quality, and alignment quality) between incentives and firm performance, and found evidence of mediation. More recently, Ambrose and Rutherford (2016) investigated the effect of collaboration as a single mediator between several antecedents (social cohesion, centralisation, information quality, procedural quality and rewards & incentives) and S&OP effectiveness. Using just 123 survey samples, they found evidence of mediation but at modest levels. Ambrose et al. (2018) further suggest that team social (or superordinate) identity not only positive impacts S&OP performance, but also fully mediates the relationship between decentralised team structures and S&OP performance, as well as that between the availability of resources/time and S&OP performance.

6.2.5. Coordination mechanisms of S&OP

There appears to be a strong case for suggesting that a strong organisational culture (or at least a strong S&OP subculture) is a pre-requisite or antecedent for a successful S&OP implementation. S&OP implementations require intra-organisational coordination and a number of coordination mechanisms have been identified as enablers for S&OP teams to accomplish their goals. For example, Grimson and Pyke (2007) propose a framework that assesses a firm's S&OP maturity via criteria related to a firm's business processes (meeting and collaboration, organisation and performance measurements) and its information processes (information technology and S&OP plan integration). These are refined by Thomé et al. (2014a & 2014b) in their model which uses four coordinating mechanisms (meetings and organisation, measurement, technological integration and integration of plans) while the framework proposed by Tuomikangas and Kaipia (2014) employs six constructs to represent S&OP coordination mechanisms, as defined in Table 6-1.

Table 6-1: S&OP Coordinating Mechanisms (Tuomikangas and Kaipia, 2014)

S&OP Coordination Mechanism	Definition
S&OP Organisation	Formal organisational S&OP Structure
S&OP Process	Formal and standardised process for conducting S&OP
S&OP Tools and Data	Processes and tools for capturing, sharing, storing and refining data needed for decision making
Performance Management	Measurement and optimisation of firm performance
Strategic Alignment	S&OP as a link between company strategy and operational planning, and reinforcing the reaching of strategic business targets
S&OP Culture and Leadership	Culture and leadership required to support and enhance S&OP

Goh and Eldridge (2018) [i.e. Chapter 5 of this thesis] investigated the effects of these six S&OP coordination mechanisms on supply chain performance. Based on a global survey of S&OP practitioners, six independent variables (to represent the six coordination mechanisms) that act on one dependent variable (Supply Chain

Performance) were included within a single structural model. Supply Chain Performance was defined as an endogenous latent variable indicated by observed variables such as: fill rate; inventory levels; lead time; and flexibility (i.e. a firm's ability to react to changes in demand or supply). Figure 6-1 shows these effects in terms of standardised coefficients. That study found that a highly formalised S&OP Procedure/Schedule (equivalent to "S&OP Process" in Table 6-1) has a significant negative effect on supply chain performance. This finding suggests that organisations that adopt a highly formalised S&OP Procedure/Schedule find it difficult to cope with fast-changing demand/supply conditions, which may be a specific manifestation of the more general findings of Sørensen (2002) described in Section 6.2.2. However, Goh and Eldridge (2018) found that the other five mechanisms generally have positive effects on supply chain performance as illustrated by the standardised coefficients in the structural model shown as Figure 6-1 ("Information Acquisition/Processing" is equivalent to "S&OP Tools and Data" in Table 6-1). Notably, the effect of S&OP Culture on supply chain performance was found to be only marginally significant and clearly weaker than indicated by in earlier studies (e.g. Eng, 2006; Grimson and Pyke, 2007; Mello, 2010; Swaim et al., 2016) which may suggest the presence of mediation effects between coordination mechanisms.

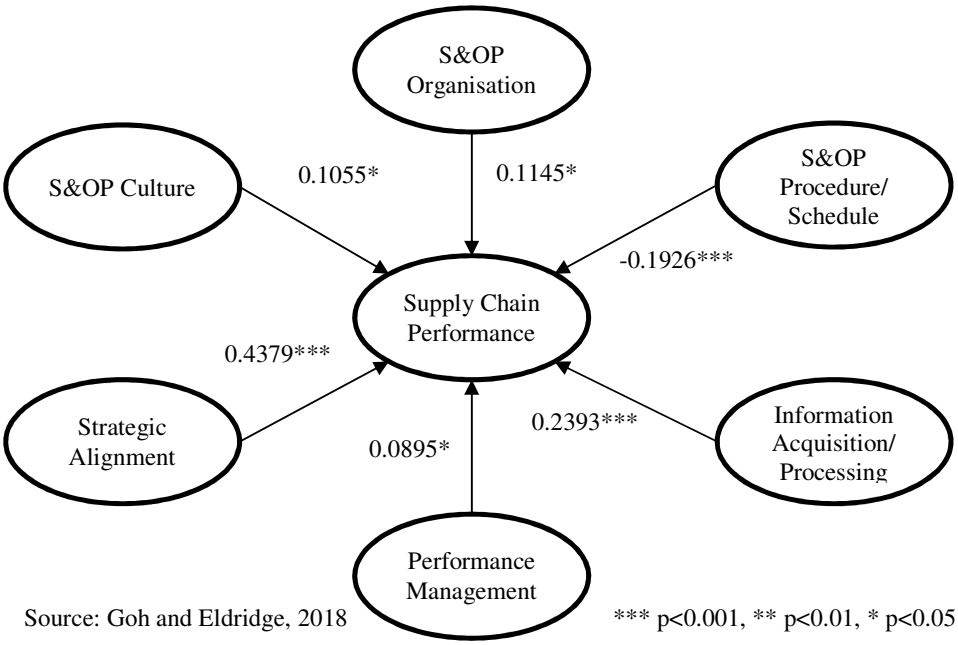


Figure 6-1: Structural Model on S&OP Coordinating Mechanisms

6.2.6. Literature synthesis and research hypotheses

Overall, prior research strongly suggests that organisational culture can impact organisational performance. However, while organisational culture has been found to be linked to supply chain collaboration/integration outcomes (e.g. Barratt, 2004; Pagell, 2004; Mello and Stank, 2005), the effect of the culture on S&OP implementations and the intervening mechanisms involved has not been similarly demonstrated. Furthermore, the findings of Goh and Eldridge (2018) paint a rather tentative picture of the direct effect of S&OP Culture on supply chain performance. This suggests that further analysis of the relationships between S&OP culture and the other non-cultural mechanisms of S&OP would be valuable.

It is interesting that, as shown in Table 6-2, the non-cultural coordinating mechanisms of S&OP as defined in Tuomikangas and Kaipia (2014)'s framework correspond closely to the consensual coping mechanisms identified by Schein (1984) for problems in

external adaption resulting from a strong organisational culture, described earlier in Section 6.2.1.

Table 6-2: Corresponding Mechanisms for Collective External Adaption versus S&OP Coordination

Coping mechanisms for external adaption determined by a collective culture (adapted from Schein, 1984)	**Coordination mechanisms for S&OP (adapted from Tuomikangas and Kaipia, 2014; Goh and Eldridge, 2018)**
Strategy, Goals (consensus on primary task and core missions)	Strategic Alignment
Means for accomplishing goals (e.g. division of labour and organisational structure)	S&OP Organisation, S&OP Procedure/Schedule
Measuring performance (measurement criteria, information and control systems)	Performance Management, Information Acquisition/ Processing
Correction (remedial actions when the group is not achieving its goals)	S&OP Procedure/Schedule

Consequently, it is possible to reframe the non-cultural coordinating mechanisms of S&OP as an organisation's internal means of coping collectively with external challenges in the supply chain. Furthermore, given the role of organisational culture as an antecedent in the supply chain coordination/integration literature, we re-examine the variables studied by Goh and Eldridge (2018) from a mediation perspective with S&OP Culture viewed as an antecedent of successful S&OP implementation. Therefore, we hypothesise:

H1: S&OP Organisation mediates the effect of S&OP Culture on Supply Chain Performance

H2: S&OP Procedure/Schedule mediates the effect of S&OP Culture on Supply Chain Performance

H3: Information Acquisition/Processing mediates the effect of S&OP Culture on Supply Chain Performance

H4: Performance Management mediates the effect of S&OP Culture on Supply Chain Performance

H5: Strategic Alignment mediates the effect of S&OP Culture on Supply Chain Performance

Our paper investigates these hypotheses by first describing the theoretical concept of mediation and the range of analytical methods available to test for mediation prior to justifying our selected approach. Then we describe the design of our study (including information on the survey procedure, sample and model validation) and report the results we obtained by using a multiple mediator model. Finally, the paper concludes with a discussion of the implications for theory and practice and identifies opportunities for further research.

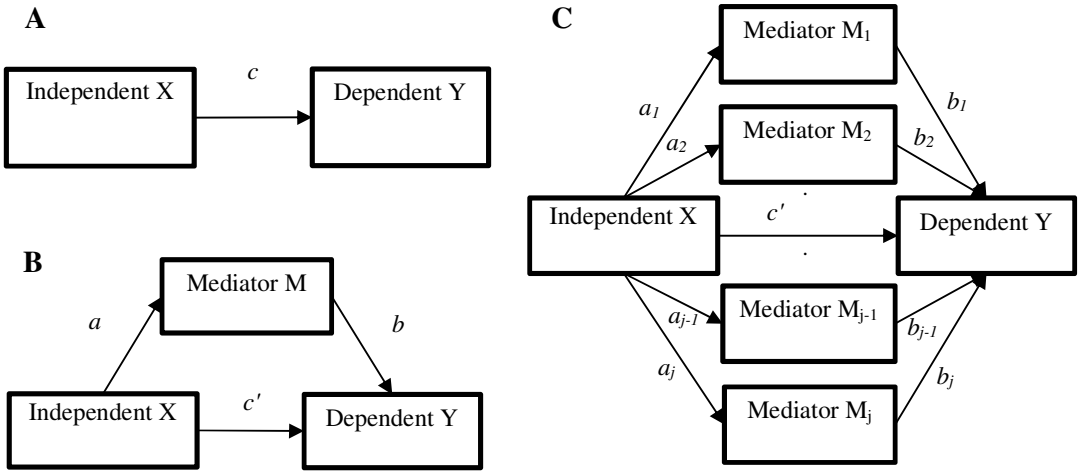
6.3. Methodology

Mediation analysis is fundamental to many substantive research areas, especially psychology as well as the social and medical sciences (MacKinnon, 2008). There is also considerable adoption of mediation analysis techniques in the field of Operations Management (OM), even though the dissemination of the latest methods among the OM research community is suggested to be slow (Malhotra et al., 2014). Moreover, Rungtusanatham et al. (2014) observe in a review of supply chain management (SCM) literature that specific indirect effects are frequently not examined by researchers when multiple mediation processes are involved, among other shortcomings.

Mediation is the generative mechanism of a third variable, through which the focal independent variable X can influence the dependent variable Y (Baron and Kenny, 1986). Alternatively, mediation is a theoretical premise that posits that an intervening

variable is an indicative measure of the process through which an independent variable is thought to impact a dependent variable (Iacobucci et al., 2007). Mediation also implies a temporal relation, with the independent X variable occurring before the mediator M, which in turn occurs before the dependent Y variable (MacKinnon, 2008). When the strength of an indirect effect depends on the level of some variable or when mediation relations are contingent on the level of a moderator, moderated mediation is said to have occurred (Preacher et al., 2007).

Structural Equation Modelling (SEM) is considered superior to regression, both for assessing the classic mediation questions and for enabling researchers to extend beyond these basic inquiries (Iacobucci et al., 2007). In most situations, it is unlikely that the effect of an independent variable on an outcome is transmitted by only one means (Preacher and Hayes, 2008). Using SEM, differences in the relative sizes of specific indirect effects through different pathways can be tested (Hayes, 2009). These paths would typically be quantified with unstandardised regression coefficients (Preacher and Hayes, 2008). Figure 6-2 shows a simple single mediator model versus a multiple mediator model.



(Adapted from MacKinnon, 2000; Preacher and Hayes, 2008; Hayes, 2009; Rungtusanatham et al., 2014)

Figure 6-2: (A) Total Effect of X on Y; (B) Simple Mediator Model; (C) Multiple Mediator Model

In a simple mediator model, the mediated effect is represented by $a \times b$ (where a and b are the regression coefficients for X→M and M→Y respectively) while the indirect effect is c'. Therefore, c ($= a \times b + c'$) represents the total effect. In a multiple mediator model, the total mediated effect is simply the sum of specific mediated effects (i.e. $c = a_1b_1 + a_2b_2 + \ldots + a_jb_j + c'$) (MacKinnon, 2000; Rungtusanatham et al., 2014).

Although the terms *mediated effects* and *indirect effects* are sometimes used interchangeably, an important distinction made by some researchers is that the presence of a mediation effect usually implies that the total effect was present initially. Yet, it is possible to find that an indirect effect is significant even when there is no evidence of a significant total effect (Holmbeck, 1997; Preacher and Hayes, 2004).

Using SEM, differences in the relative sizes of specific indirect effects though different pathways can be tested (Hayes, 2009). Mediation analysis is most compelling when alternative theories predict different mediational pathways. A multiple mediator model

can demonstrate multiple mediational processes in the relation between an independent and a dependent variable (MacKinnon, 2008). It also allows the researcher to determine the relative magnitudes of the specific indirect effects associated with all mediators and to "tease apart" individual mediating effects often attributable to several potentially overlapping mediators (Preacher and Hayes, 2008). Moreover, the likelihood of parameter bias due to omitted variables is reduced in a multiple mediation model, compared to when several simple mediation hypotheses are each tested singly with a simple mediator model (Preacher and Hayes, 2008).

Baron and Kenny (1986)'s causal-steps test has been the most commonly-used test of mediation (Fritz and MacKinnon, 2007) but recent research studies have highlighted the deficiencies of this test (e.g. Hayes, 2009; Zhao et al., 2010; Rucker et al., 2011; Rungtusanatham et al., 2014). First, the causal-steps test has low statistical power, unless the effect or sample size is large (MacKinnon et al., 2002). Another weakness of this test is that even if there is no significant relationship between the independent and dependent variables, mediation can still exist. This is because the test of the mediated effect may have more statistical power than the test of the overall relation of X on Y in some situations (MacKinnon, 2008) or if c and $a \times b$ are of opposite signs (MacKinnon, 2000; Zhao et al., 2010).

The Sobel test (Sobel, 1982) is an alternative inferential technique in which the ratio of $a \times b$ to its standard error is used as a test statistic for testing the null hypothesis that the ''true'' indirect effect is zero. However, the Sobel test requires the assumption that the sampling distribution of the indirect effect is normal (Hayes, 2009; Rungtusanatham et al., 2014). If normality of the sampling distribution cannot be assumed, bootstrapping is advocated for testing mediation. Bootstrapping, which appears to be sparsely used in the field of OM (Malhotra et al., 2014), involves repeatedly sampling from the data set

and estimating the indirect effect in each resampled data set (Preacher and Hayes, 2008; Rungtusanatham et al., 2014).

To report the presence and extent of mediation, Baron and Kenny (1986) propose the "full", "partial" and "no" mediation scale. This has been challenged (Zhao et al., 2010; Rucker et al., 2011) and Zhao et al. (2010) recommend an alternative scale with three patterns consistent with mediation and two with non-mediation:

- Complementary mediation: Mediated effect ($a \times b$) and direct effect (c') both exist and point in the same direction.
- Competitive mediation: Mediated effect ($a \times b$) and direct effect (c') both exist and point in opposite directions.
- Indirect-only mediation: Mediated effect (a×b) exists, but no direct effect.
- Direct-only non-mediation: Direct effect (c') exists, but no indirect effect.
- No-effect non-mediation: Neither direct effect nor indirect effect exists.

6.4. Design and Sampling

The data for this study was derived from the survey conducted by Goh and Eldridge (2018). In February 2016 to January 2017, personalised invitations were sent to about 3,600 individual supply chain professionals who met the criteria for experience in S&OP, from a global pool of more than 15,000 individuals in several S&OP interest groups on LinkedIn (a professional social networking platform). The criteria used for targeted respondents include those people who had "S&OP" (or closely-related terms such as "SIOP" – Sales Inventory & Operations Planning) in their job titles, job descriptions, skills or profile summaries in LinkedIn. Qualtrics was used to conduct a self-administered questionnaire, in which respondents stated (on a 7-point Likert scale) the extent to which they agreed with a series of statements on S&OP coordination and

supply chain performance at their organisations. The response rate was about 19% with 683 complete responses being received.

Responses were then screened prior to analysis. Only complete responses were saved and hence no answers were imputed. Six respondents indicated they did not practise S&OP at their current organisations (even though they may be familiar with S&OP) while another 64 respondents practised only an informal form of S&OP at their organisations. These responses were disregarded. A further 45 responses were discarded as the respondents were disengaged (e.g. providing the same answers to nearly all the question items and failing to answer the "attention trap" questions correctly). The eventual set of 568 responses comprised a diverse set of respondents who represent a wide cross-section of S&OP roles, industries and geographical locations (87 countries).

Table 6-3 shows the profile of respondents to the survey, the business units whose S&OP implementations were reported on and the characteristics of the products that respondents' business units dealt with.

Table 6-3: Respondent, Business Unit and Product Profiles (N=568)

Role		Sub-Region	
Demand planning	221	Western & Northern Europe	81
Procurement & supply management	135	USA/Canada	75
Manufacturing & operations management	73	Latin America	67
Logistics management	44	Sub-Saharan Africa	63
General management	20	East Asia & Pacific	59
Sales or account management	13	Middle East & North Africa	57
Finance	4	Central & Southern Europe	54
Other	58	South East Asia	50
		South Asia	37
		Eastern Europe & CIS*	25

No. of Employees (Firm)		Industry	
50,000 and above	242	Food Products	88
10,000 to 49,999	155	Life Science and Healthcare Products	59
5,000 to 9,999	63	Energy and Chemicals	54
1,000 to 4,999	74	Household and Personal-Care Products	53
500 to 999	18	Beverages	51
<500	16	High-Tech and Consumer Electronics	48
S&OP Experience		Industrial Equipment	41
> 10 years	95	Automotive	41
> 5 to 10	171	Retail and Distribution (Multi-Products)	31
> 2 to 5	160	Apparel, Footwear and Textiles	17
0-2	142	Agriculture and Agribusiness	15
		Aerospace and Defense Equipment	11
		Mining	9
		Other	50

Daily Order Volume		SKU Variety		Product Lifecycle	
500 orders or more	243	>5,000 SKUs	163	>10 years	114
200 to 499	104	2,000 to 5,000	109	>5 to 10	126
50 to 199	143	500 to 1,999	116	>2 to 5	163
10 to 49	56	100 to 499	129	>1 to 2	92
<10	22	<100	51	1 or less	73

* Commonwealth of Independent States; Based on *Goh and Eldridge (2018)*

SPSS 23 was used to check for factor loading, while AMOS 22 was adopted for Structural Equation Modelling. The data set was tested under several criteria (e.g. model fit, discriminant validity, convergent validity, cross validity, reliability, configural invariance, metric invariance, common method variance, endogeneity and selection/self-selection bias) and found to be satisfactory (Goh and Eldridge, 2018). For example, the presence of endogeneity (which can be attributed to common-method variance, omitted causes, predictor-outcome simultaneity or measurement errors) was tested under a two-stage least-square procedure and the Durbin-Wu-Hausman chi-

squared test (Davidson and MacKinnon, 1993). However, endogeneity was not found to be a significant problem at the 5% level (p=0.254). Supply Chain Performance was controlled for firm size, years of S&OP experience, daily order volume, SKU variety and product lifecycle. These and other details (on survey design, constructs, factor loadings, etc) are available from the corresponding author on request.

One particular challenge of asymmetric distributions is that large sample sizes of approximately 500 are necessary to detect small effects in the path coefficients (Fritz and MacKinnon, 2007; MacKinnon, 2008), a condition fulfilled by the initial data set in Goh and Eldridge (2018). Furthermore, in our study, resampling was conducted using 5,000 bootstrap samples and a 95% bootstrap confidence bias-corrected (to adjust for skewness in the bootstrap distribution) percentile method (MacKinnon et. al. 2004).

6.5. Findings

Figure 6-3 shows our multiple mediator model with unstandardised path coefficients, as well as the significance of the mediating paths (but control variables are not shown).

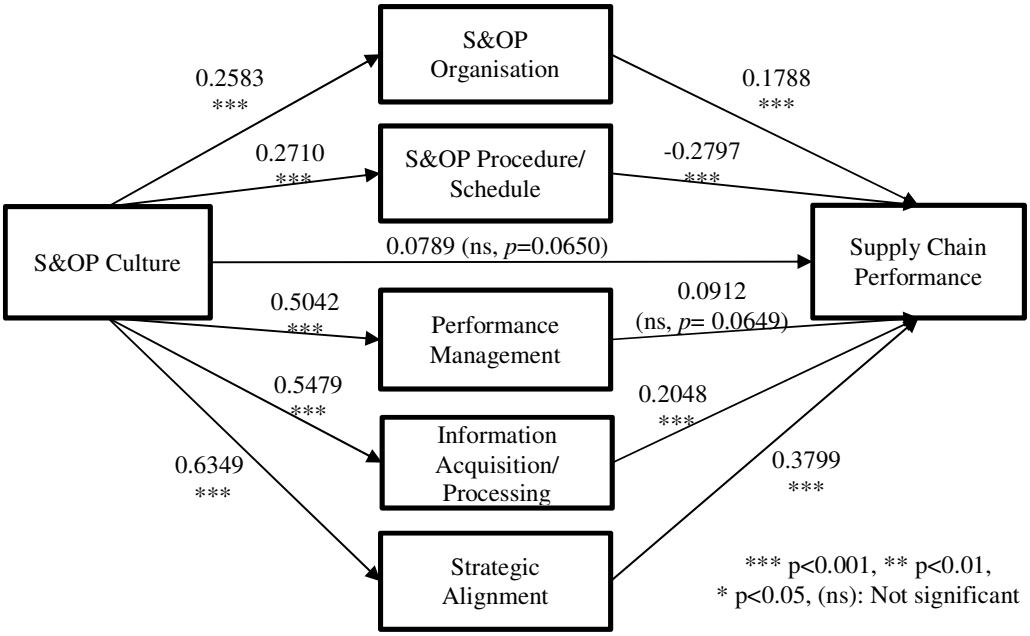


Figure 6-3: Multiple Mediator Model for Effects of S&OP Culture on Supply Chain Performance

Table 6-4 shows the results of the 5 hypotheses tested using the model in Figure 6-3. It can be observed that S&OP Culture only has a marginally insignificant (p=0.650) direct effect (c'=0.0789) on Supply Chain Performance were it not for the mediating roles played by the S&OP Organisation, Information Acquisition/ Processing and Strategic Alignment mechanisms.

Table 6-4: Results of Mediation Analysis and Hypotheses Testing

Unstandardised effects and two-tail significance (bias corrected)	**Mediator**				
	S&OP Organisation	**S&OP Procedure/ Schedule**	**Information Acquisition/ Processing**	**Performance Management**	**Strategic Alignment**
Hypothesis	H1	H2	H3	H4	H5
Total effect (*c*)	0.4487 ***				
Direct effect (*c'*)	0.0789 (ns, p=0.0650)				
Indirect effect ($a_i \times b_i$)	0.0462 *	-0.0758 ***	0.1122 ***	0.0460 (ns)	0.2412 ***
Mediation type based on Baron and Kenny (1986)	Full mediation	Full mediation	Full mediation	No mediation	Full mediation
Mediation type based on Zhao et al. (2010)	Complementary mediation	Competitive mediation	Complementary mediation	Direct-only, no mediation	Complementary mediation

**** $p<0.001$, ** $p<0.01$, * $p<0.05$, (ns): Not significant*

Based on Baron and Kenny (1986)'s mediation scale, "full mediation" can be concluded for Hypotheses *H1*, *H2*, *H3* and *H5*. However, given the lack of clarity of the term "full mediation" (Zhao et al., 2010) and given that the direct effect (*c'*) exists but is only borderline insignificant at the 5% level, we also adopt Zhao et al. (2010)'s terminology in our classification for mediation type (but with a slightly relaxed definition of the significance of the direct path).

We find that the relationship between S&OP Culture and Supply Chain Performance is most strongly mediated *complementarily* by the Strategic Alignment and Information Acquisition/Processing coordinating mechanisms, while the mediating role of S&OP Organisation is relatively weak. Conversely, S&OP Procedure/Schedule acts as a *competitive mediator* between S&OP Culture and Supply Chain Performance (i.e. the direct and indirect effects have opposite signs). Lastly, Performance Management does not have a significant mediating role in the model, even though the former is strongly linked (a=0.5042, p<0.001) to S&OP Culture. Overall, indirect effects account for more than 82% of the total effect. Figure 6-4 illustrates the relative magnitudes of these effects.

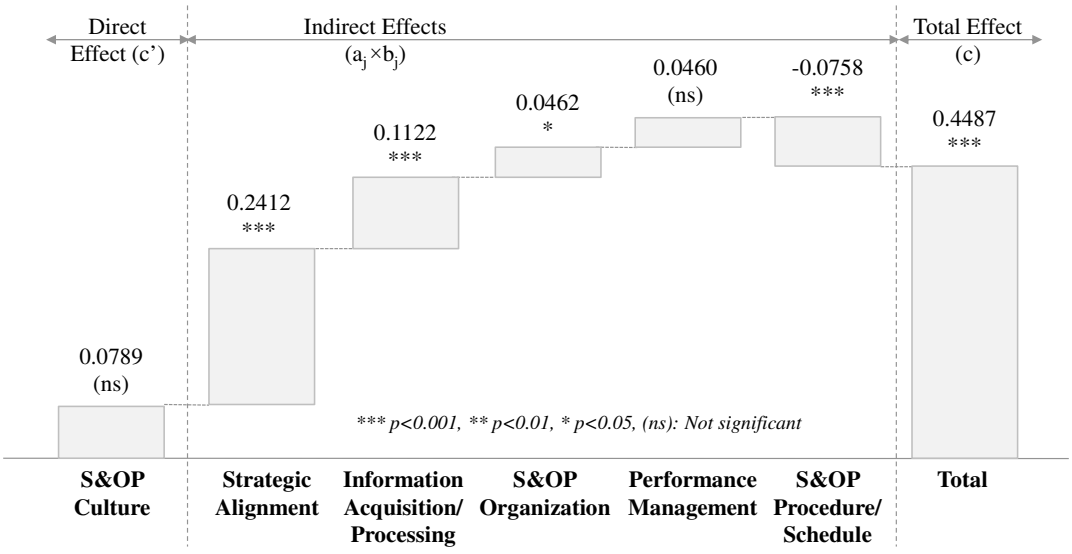


Figure 6-4: Magnitudes of Direct, Indirect and Total Effects of S&OP Culture

6.6. Discussion and Conclusion

The correlation between organisational culture and firm performance is well-researched in the literature (e.g. Gordon and DiTomaso, 1992; Kotter and Heskett, 1992; Eng, 2006), as are the ingredients of "mature" S&OP practices (e.g. Grimson and Pyke, 2007; Thomé et al., 2014a & 2014b; Tuomikangas and Kaipia, 2014). Studies on the means through which superior organisational cultures act towards better coordination outcomes are far less common, although Ambrose et al. (2018) suggest that superordinate identity is achievable in an S&OP context as well as other cross-functional team settings that share similar characteristics.

This study builds upon the above past research and extends the results in Goh and Eldridge (2018). We investigate S&OP Culture as an antecedent to S&OP coordination mechanisms by reframing the latter as an S&OP team's internal means of coping collectively with challenges to be resolved in a supply chain. Our results show that that

S&OP Culture has a weak *direct* effect on Supply Chain Performance. While a strong S&OP Culture mechanism does ultimately lead to better coordination outcomes, the former's effects are most amplified when transmitted *indirectly* via the Strategic Alignment pathway. This transmission mechanism has been hinted at by Oliva and Watson (2011) who found that achieving *alignment* in the execution of plans can be more important than informational and procedural quality.

Our results also show that the Information Acquisition/ Processing mechanism is another important conduit through which a strong S&OP Culture exerts indirect effects on Supply Chain Performance. As Mello (2010) aptly explains (albeit in a negative reinforcement manner), "game playing by functional units degrades the accuracy of the data S&OP requires to set plans and operations for the future. A corporate culture that tolerates game playing will fail to adequately support the data accuracy critical to S&OP."

The lack of a significant mediating effect by the Performance Management mechanism between S&OP Culture and Supply Chain Performance resonates with the findings by Pagell (2004), who points out that firms that are more concerned with measuring individual outcomes (rather than team-based outcomes) may use these measures to "place blame" rather than to find solutions. Resultantly, a seemingly "strong" S&OP Culture may foster strong Performance Management capabilities but not necessarily better Supply Chain Performance, as shown in our analysis.

Although various S&OP coordination mechanisms have been identified in the literature, they tend to be viewed as standalone mechanisms that are distinct from one another (e.g. Grimson and Pyke, 2007; Tuomikangas and Kaipia, 2014). Instead, our results suggest that coordinating mechanisms should not be viewed in isolation, but rather they could

be mediated by each other. S&OP Culture is a particularly complex and multifaceted coordination mechanism. It may not be easily discernible, but it nonetheless plays an important role in organisations implementing S&OP, via its indirect effects on Supply Chain Performance.

Another important implication of our study is that due to competitive mediation, a strong S&OP culture could concurrently promote strong processes that hinder change and partially suppress Supply Chain Performance, particularly during volatile environments when the benefits of strong cultures disappear (Sørensen, 2002). While strong organisational culture can promote good performances and shape members' perceptions of the value of their work, those cultures can also be characterised by arrogance, inward focus, and bureaucracy, which undermine an organisation's ability to learn and adapt (Saffold, 1988; Kotter and Heskett, 1992). This finding is also in line with the negative links between the organisational culture and the degree of internal integration in supply chains (Braunscheidel et al., 2010; Cao et al., 2015).

Therefore, from a duality perspective, a strong S&OP culture can simultaneously exhibit both reinforcing and suppressing mediated effects on Supply Chain Performance, due to the non-monotonic effect of culture (Saffold, 1988). Firms should strike a delicate balance between having a strong culture that effectively guides internal alignment and the sharing of accurate data, and one that institutionalises agile processes that are receptive to feedback. If the cultural balance is upset, a "*strong-culture conundrum*" may arise such that in an extreme dichotomous case, the positive effects of S&OP become completely suppressed, even though a nominally "strong" S&OP culture is seemingly in place. This "strong-culture conundrum" would help explain why the effect of S&OP Culture on Supply Chain Performance is weaker than expected in the study by Goh and Eldridge (2018). Our finding is thus in line with the conclusion

of Gordon and DiTomaso (1992) who suggest that firms need to find a combination of not just strong culture (in terms of consistency), but also appropriate culture (in terms of adaptability). These results also lend support to the concept of ambidexterity (advocated by researchers such as Gibson and Birkinshaw (2004) and Blome et al. (2013)), in which organisations simultaneously achieve alignment and adaptability by encouraging individuals to make their own judgments as to how best divide their time between conflicting demands.

This current study is not without its limitations. First, our focus is on S&OP Culture as an antecedent (or independent variable) in the mediation model. Other coordinating mechanisms have not been modelled as antecedents (due to a lack of theoretical grounding from the extant literature), nor is *moderated mediation* in the scope of our study. Second, this study is concerned with coordination in the context of Sales and Operations Planning and an S&OP Culture may in reality be just one of several connected subcultures within a wider organisation. Hence, these results cannot be generalised to firms that are using other forms of coordination or to other dimensions of organisational culture. One potentially interesting area for future research would be how S&OP Culture interacts with the other subcultures that are often present in the rest of the organisation.

Notwithstanding these limitations, our research has contributed to the literature in several ways. This is the first study that has investigated potential mediation effects between selected coordination mechanisms of S&OP and developed a multiple mediator model via a large-scale global survey, in accordance with current best practices for the theorizing of and testing for mediation effects (Rungtusanatham et al., 2014). Our study has successfully distilled the individual mediators and quantified their strengths in translating a strong S&OP culture to improved Supply Chain Performance,

an approach that is uncommon in the Operations Management literature (Malhotra et al., 2014). Moreover, we have uncovered empirical evidence for an S&OP Procedure/Schedule mediating pathway through which a strong S&OP Culture may inadvertently suppress Supply Chain Performance. Our findings will therefore enable S&OP practitioners and leaders to better understand how their own organisations' S&OP Culture can be shaped to achieve superior Supply Chain Performance.

Chapter 7 – Overall Conclusion

This thesis began by introducing the importance of congruence and coordination in the supply chain, which are embedded within very definitions of supply chain management and its philosophy (Ross, 1997; Mentzer et al., 2001). In the introductory chapter, it was highlighted that firms face challenges in achieving congruence for a variety of internal and external reasons. Internal factors especially often hinder intra-firm coordination and hence hurt the competitiveness of supply chains in dealing with external challenges (Fawcett and Magnan, 2002).

The core of this research has been focused on S&OP as an intra-organisational coordination tool to balance between demand and supply (Muzumdar and Fontanella, 2006) and drive cross-functional consensus on sales forecasts, capacity and/or production plans (Lapide, 2004a). The purpose of this thesis is to develop a deeper understanding of S&OP, based on empirical evidence and in turn the specific means through which supply chain performance is impacted.

The theoretical foundations and relevant theories in management and organisation science were gathered in Chapter 2, upon which the premise and hypotheses in the three chapters were built from a research framework that draws upon several concepts, including the resource-based view theory, interdependence and organisational design. One key insight derived from the review of literature is that for S&OP programmes to be effective, they should have the ability to handle not just uncertainties but also equivocality, which is characterised by a lack of consensus within cross-functional teams (Frishammar et al., 2011). Another insight is that that although S&OP has several distinct characteristics and research themes that set it apart from the concepts of supply

chain integration and the marketing-operations interface, these concepts are each epitomised by a set of interactions between stakeholders of different functional backgrounds, with the promise of improving various aspects of firm performance. Yet, academic research on S&OP within the umbrella of supply chain coordination/collaboration has been limited in the operations management literature. Furthermore, behaviours of key actors within S&OP are less established from an organisation science perspective (Oliva and Watson, 2011).

In view of these gaps in the literature, three research questions have been formulated and addressed respectively in the three papers in Chapters 4 to 6. The key results and some general conclusions from the three papers are extracted and presented in the next section. Additionally, several implications, limitations as well as suggested future directions of research are discussed in the rest of this chapter.

7.1. Summary of Results

Grimson and Pyke (2007)'s research paper on the maturity of S&OP programmes has provoked much research and debate in the past decade, on the extent to which implementing S&OP provides tangible benefits to a firm. Their results suggest that "mature" S&OP implementations lead to better performance, but such evidence is uncommon in the academic literature (Qi and Ellinger, 2017; Noroozi and Wikner, 2017). The paper included in Chapter 4 of this thesis is hence intended to answer the first research question in this thesis (***TQ1***). Results of this paper show that in the case studies of the two separate companies, both cases show significant quantifiable improvements in supply chain performance from implementing S&OP. 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 by integrating a supplier into an existing S&OP programme.

The impetus for the second research question (***TQ2***) is the study by Tuomikangas and Kaipia (2014), who found from an extended review of the literature that there are six coordination mechanisms of S&OP, namely S&OP Organisation, S&OP Process, S&OP Tools and Data, Performance Management, Strategic Alignment and S&OP Culture and Leadership. However, several researchers have noted that the efficacy of S&OP coordinating mechanisms are not necessarily fixed but rather are dependent on environmental, contingent or contextual factors (Thomé et al., 2014b; Ivert et al., 2015; Kaipia et al., 2017; Kristensen and Jonsson, 2018). This thus motivates the conduct of a large-scale survey (in Chapter 5) that not only tests Tuomikangas and Kaipia (2014)'s propositions, but also the effect of contingency factors. Results of the paper in Chapter 5 of this thesis indicate that Strategic Alignment and Information Acquisition/Processing are the mechanisms that most significantly enable superior S&OP outcomes. However, the survey dataset strongly suggests that a highly formalised S&OP Procedure/Schedule inhibits supply chain performance. Furthermore, from a contingency theory perspective, increasing firm size and increasing experience in S&OP amplify the negative effect of a standardised S&OP Procedure/Schedule upon supply chain performance.

In the final phase of this study, the aim is to investigate the effect of organisational culture as an antecedent to S&OP coordination mechanisms. This is inspired by the rich body of research in the literature which suggests that the collective ethos of an organisation is a key variable in models of organisational integration (e.g. Pagell, 2004; Mello and Stank, 2005; Cao et al., 2015). Hence, to answer the third research question

(***TQ3***), it was hypothesised in the paper in Chapter 6 that the effect of S&OP Culture acts through the other five coordinating mechanisms. Results of this paper show that a strong S&OP culture leads to better overall coordination outcomes, but the former's effects are primarily transmitted indirectly through the Strategic Alignment and Information Acquisition/Processing coordination mechanisms. Yet, a strong S&OP culture may concurrently suppress Supply Chain Performance via the S&OP Procedure/Schedule pathway due to competitive mediation.

7.2. Reflections on Implications of Results

In attempting to explain and predict improvements in performance from implementing S&OP, one important implication from the above findings is that the theories underpinning S&OP and the broader field of organisation integration are multi-disciplinary. They straddle several domains, including the organisation science and operations management disciplines (Oliva and Watson, 2011). The interdependence and knowledge-based views (and to a lesser extent the transaction-cost view) of the firm help explain why coordination programmes such an S&OP are needed, while the resource-based theory suggests that S&OP can confer benefits to firms and potentially be a source of competitive advantage (at least in the short term). Yet, the resource-based theory does not fully explain the advantages from implementing S&OP, for S&OP coordinating mechanisms are not particularly unique and are somewhat imitable among firms that implement S&OP. Moreover, not all firms obtain similar results from S&OP despite efforts to imitate S&OP "best practices", which lends support to Sousa and Voss (2008)'s scepticism of the universal validity of such so-called "best practices". This current research shows that this phenomenon can be explained via contingency theory that has also been adopted in several recent studies (e.g. Thomé et al., 2014b; Ivert et

al., 2015; Kaipia et al., 2017; Kristensen and Jonsson, 2018). Contingency theory suggests that since firms operate in different environments and settings (such as industry, region and product attributes), managers may not all be able to easily identify and make the required changes to the attributes of their organisations to harness the greatest benefits from S&OP.

Likewise, this research also has implications on organisational theory, especially in the areas of organisational ambidexterity and bricolage. Formalised procedures are often advocated in the S&OP practitioner literature (e.g. Lapide; 2004a, Boyer, 2009, Milliken, 2008; Smith et al., 2010), but results from this thesis have shown that highly formalised S&OP procedures inhibit supply chain performance, which suggest that under some circumstances the concept of bricolage may be effective in coordinating S&OP programmes.

Another theoretical implication of this research relates to the means through which an organisation's culture influences its performance. Drawing from the academic literature on internal integration and the market-operations interface, organisational culture has been found to act as an antecedent of S&OP coordinating mechanisms to S&OP performance outcomes. Due to the non-monotonic manner in which an organisation's S&OP culture impacts S&OP coordinating mechanisms, a strong culture may not necessarily always lead to strong S&OP outcomes. Rather, formalised procedures arising from a strong S&OP culture may have a diluting effect on supply chain performance, which is in line with the observations by earlier researchers such as Saffold (1988).

The results from this thesis also have several managerial implications. The two case studies have shown that S&OP can be an effective supply chain coordination tool with

measurable results. They are also supportive of the notion of a maturity model for S&OP implementations (e.g. Grimson and Pyke, 2007), which can be useful in helping firms investigate areas for further performance gains. However, practitioners should be aware that maturity models are at best indicative of the level of maturity of S&OP implementations and they do not directly determine supply chain performance. Rather, from the organisational and process design perspectives, S&OP performance is dependent on S&OP coordinating mechanisms and thus managers should focus on developing the individual coordinating mechanisms that have the greatest impact on performance instead of overall high levels of S&OP maturity.

In addition, while S&OP can be adapted to organisations in different industries and environments, supply chain priorities and firm orientations may vary (Chen et al., 2009; Qi and Ellinger, 2017). Performance gains from implementing S&OP are also moderated by contextual factors such as product profiles, firm size, industry and region (Thomé et al., 2014b; Ivert et al., 2015; Kaipia et al., 2017; Kristensen and Jonsson, 2018). Hence, despite the generic nature of S&OP as an intra-organisational integration tool, managers should actively customise S&OP implementations according to industry, region and product attributes, rather than depend on templatised designs.

7.3. Contributions to Literature

This thesis has contributed to the S&OP literature in three key ways. First, the findings from the first paper (in Chapter 4) have illustrated the potential quantitative benefits of adopting S&OP and the circumstances under which these benefits may be achieved. In particular, this paper has shed light on how companies can reap incremental performance improvements as their designs of S&OP programmes become more mature

and how such performance gains can be measured over time or across product lines. The paper in Chapter 4 thus strengthens the link between practitioner and academic literature on supply chain coordination by providing empirical evidence (and not just anecdotal evidence) of the benefits of S&OP.

Second, results from the next paper in Chapter 5 have provided strong empirical evidence that the strength of individual coordination mechanisms can be significantly impacted by several important contingency factors (such as firm size, S&OP experience, product variety, industry and region). Furthermore, that formal procedure or schedule was found to inhibit performance of S&OP programmes suggests that organisational bricolage (Bechky and Okhuysen, 2011) may be a coordinating mechanism of effective S&OP programmes and hence managers should consider empowering ambidextrous S&OP teams to maintain balance using self-governing event-driven processes. This paper makes a novel contribution to the S&OP literature by providing (via abductive reasoning) possible evidence of a theoretical construct (organisational bricolage), which may trigger a re-evaluation of the efficacy of prescriptive S&OP procedures that have been advocated by some researchers and practitioners. However, the precise way in which organisations can design S&OP programmes to take advantage of bricolage needs to be further investigated, but this is beyond the scope of this thesis.

Third, the final paper in Chapter 6 has contributed to the literature at the interface of Organisational Science and Operations Management by presenting a model of S&OP Culture as an antecedent of effective S&OP programmes. The results demonstrate that a strong S&OP culture can simultaneously exhibit both reinforcing and suppressing mediated effects on Supply Chain Performance, due to the non-monotonic effect of culture (Saffold, 1988). Such a phenomenon would explain why in an extreme

dichotomous case, the positive effects of S&OP can become completely suppressed, even though a nominally "strong" S&OP culture is seemingly in place. While the ambidexterity concept was originally conceived to address the trade-off between efficiency and innovation in manufacturing, the results in this study would also suggest that concept could potentially extend to S&OP, such that organisations may benefit from adopting a degree of contextual ambidexterity (Gibson and Birkinshaw, 2004; Blome et al., 2013) by allowing S&OP teams to make their own judgments to strike a balance between alignment and adaptability.

7.4. Limitations and Suggestions for Future Research

As indicated in the previous chapters, each of the three individual papers has its own limitations. Collectively, this research has several broader limitations. First, from a methodological view, case studies and surveys are characterised by their different strengths and weaknesses. Case studies can provide depth but lack breadth, while the converse is true for survey-based studies (Yin, 2013). In particular, large-scale surveys of managers and businesses by their nature often rely on self-reported performance indicators that may not be as objective as performance indicators that can be gleaned from case studies. This research uses a mixed methodology across three papers that can answer the three research questions in a more holistic approach (Golicic et al., 2005; Mangan et al., 2004). This however does not completely overcome the limitations of the case study and survey methods. Consequently, there is certainly scope for larger-scale case studies to follow up with selected respondents with regard to the specific results from the survey that form the basis for the results in Chapters 5 and 6 of this thesis.

Second, these results focus on S&OP, which is but one type of supply chain coordination and hence may not be generalised to other types of organisational coordination. In particular, this thesis draws upon some of the concepts and frameworks from the supply chain coordination academic literature (especially MOI and SCI), in developing the propositions and hypothesis relevant to S&OP. Furthermore, theoretical concepts from organisational science, such as ambidexterity and organisational bricolage, have been proposed to be applicable to the S&OP implementation context, but given the abductive nature of these propositions, there may be the limits to their transferability and generalisation from the empirical settings in which they originate to the S&OP setting. As Mantere and Ketokivi (2013) point out, such an abductive link does not rule out alternative hypotheses but it only signals empirical adequacy of these concepts. Nonetheless, there is room for continuous work to establish closer links between industry experience in S&OP and the theoretical foundations in organisational coordination.

Third, S&OP coordination mechanisms have been represented as constructs in this study, which are in turn operationalised as measurement items designed based on an extensive review of the practitioner and academic literature. Although this research has closely adhered to the guidelines in developing and testing measurement scales as advocated by researchers such as Malhotra and Grover (1998), the accuracy of the measurement items eventually chosen to represent the constructs is nevertheless limited by the degree of congruence between the literature's definition and the industry's understanding of S&OP coordinating mechanisms. On a related note, while results from this thesis suggests the presence of bricolage effects on supply chain performance, the specific dynamics of role shifting, reorganising routines and reordering (Bechky and

Okhuysen, 2011) in S&OP are not in the scope of this study and could be a potential area of future research.

Fourth, consideration of incentives in S&OP has been omitted in this study, due to mixed evidence in the literature (e.g. Oliva and Watson, 2011). Furthermore, Gulati et al. (2005) note that coordination does not necessarily require an alignment of interests. Nonetheless, at least one study (Ambrose and Rutherford, 2016) asserts that rewards and incentives are the greatest overall driver of S&OP effectiveness. Given the large number of stakeholders involved in S&OP with their own incentives (Sodhi and Tang, 2011) and the absence of price mechanisms to promote autonomous outcomes (Williamson, 1991), it would appear that incentive alignment would be difficult to achieve in practice within most intra-organisational settings (Oliva and Watson, 2011). Nonetheless, the effect of incentive alignment as an antecedent in S&OP implementations, how incentives can be designed and the extent to which incentives can mitigate the lack of efficacious S&OP coordinating mechanisms can all be potentially explored in a large-scale cross-case study.

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