Sales and Operations Planning: The Effect of Coordination Mechanisms on Supply Chain Performance

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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 hypothesized 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 formalized 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 standardized S&OP Procedure upon supply chain performance. Our results suggest that organizational bricolage may be a coordinating mechanism of effective S&OP programs 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 (organizational bricolage), which may trigger a re-evaluation of the efficacy of prescriptive S&OP procedures that have been advocated by some researchers and practitioners.

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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 realize 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, organization 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 realize the expected benefits from S&OP implementation but this remains to be tested. Furthermore, some coordination mechanisms may be more influential in realizing 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.

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 organization science, and their roles in coordinating the marketing-operations interface.

2.1. Coordination and the marketing-operations interface

Coordination can be viewed as the resolution of intraorganizational goal conflict (Lawrence and Lorsch, 1967a) and an organization can achieve this by managing dependencies between activities (Malone and Crowston, 1994). Typically, organizations create specialist functions to carry out these activities when the organizational 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 organizations 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 realize 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 organizations coordinate their work: mutual adjustment, direct supervision, standardization of work processes, standardization of work outputs, and standardization 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.

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) 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 generalize 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 organizational integration positively influences a standardized S&OP process. In addition, both the S&OP process and prioritization lead to stronger organizational 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 standardized S&OP process could arguably have led to stronger organizational engagement as much as stronger organizational engagement could have led to a standardized 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.

2.3. S&OP maturity, organizational 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 program 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 organizational 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 organization 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 organizational 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 organizations are those capable of implementing not just evolutionary (i.e. incremental) and also revolutionary change. Superior performance is expected from ambidextrous organizations 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, organizations can simultaneously achieve alignment and adaptability (Gibson and Birkinshaw, 2004) via “contextual ambidexterity”. Organizational ambidexterity is closely linked to the concept of bricolage, in which organizations engage in role shifting,

reorganizing routines and reordering in response to uncertain or surprising situations (Bechky and Okhuysen, 2011).

2.4. S&OP and contingency

In the context of contingency theory, "organizational 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 organizational 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 organizational characteristics. Therefore, S&OP implementation features in a variety of environments and organizational 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 organizations 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) analyzed 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 organizations to harness the greatest benefits from S&OP.

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 organizational functions. S&OP maturity models tend to advocate more closely-integrated organizations, 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 generalized (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 organization science and contribute to the S&OP literature that is traditionally operations management-focused. We analyze the strength of the links between S&OP practices and overall supply chain performance using survey-based Structural Equation Modeling (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 organizational settings under which some of these mechanisms can become more (or less) important?

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 organization, 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 1 to represent S&OP coordination mechanisms.

Table 1 – S&OP Coordinating Mechanisms (Tuomikangas and Kaipia, 2014)

S&OP Coordination Mechanism	**Definition**
S&OP Organization	Formal organizational S&OP Structure
S&OP Process	Formal and standardized 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 optimization 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.

3.1. S&OP Organization

To aid coordination, interactions between members in organizations can help provide clear signals about tasks, behaviors, and expectations of their roles as well as the roles of others and the relationships between them (Bechky, 2006). Some organizations 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 specialized 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 Organization" 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 program (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 organization 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 hypothesize:

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

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 standardized (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 organization (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 behaviors 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 hypothesize:

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

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 organization 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 organization (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 hypothesize:

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

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 organizational units to senior management (Martinez and Jarillo, 1989). Instead of specifying behaviors, the organization sets goals to be achieved and the employees select the behaviors 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 visualized) 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 standardized measures that would enhance organizational transparency and improve process analysis, ultimately leading to organizational changes.

S&OP performance metrics should balance between the interests of various parties in the organization (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 hypothesize:

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

3.5. Strategic Alignment

Organizational 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). Behaviors 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 behaviors 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 hypothesize:

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

3.6. S&OP Culture

An organization's culture can be described as a set of known values that are shared throughout the organization. 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 organizational culture (including trust, commitment, vision and top management support) as antecedents to a firm's supply chain orientation, which is the recognition by an organization 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 organization's culture that coordinate an S&OP program. In particular, there should be effective communications of business objectives and vision (Godsell et al., 2010; Tuomikangas and Kaipia, 2014; Van Hove, 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).

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

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

3.7. Theoretical model

Figure 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.

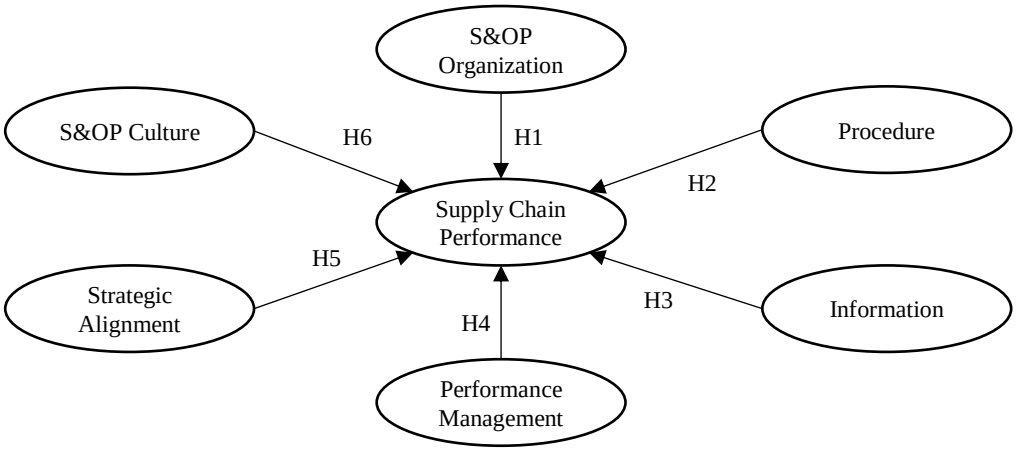


Figure 1 – Theoretical Model and Hypotheses based on S&OP Coordinating Mechanisms

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 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.

4. METHODOLOGY

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 programs. Prospective respondents were those informants who had implemented, led or regularly participated in their business units' S&OP programs.

In August 2014, an exploratory pilot survey was first launched on 25 organizations 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 organizational 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 programs 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 programs, 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 organizations' 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 "organizational integration" in organizational 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 organization, 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 (organizational integration, standardized S&OP processes, organizational priority and organizational 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 programs 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 standardized means for respondents to report (rather than instruct respondents on how to measure) the extent an S&OP program 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 & 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 finalized 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. Measurement items (i.e. survey questions) that survived the EFA reduction process can be found in the Appendix.

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 standardized measuring scale was used. Respondents were asked to assess the effectiveness of S&OP across several metrics at their organizations, 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 programs). 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).

4.2. Survey sampling

Conventional survey sampling tends to use lists of organizations 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), personalized 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 organizations; 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 practice S&OP. Another 64 respondents did not formally practice S&OP at their current organizations (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 organizations 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 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 organizations 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 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 practice S&OP at their organizations and resultantly there were no instances in our final dataset in which all S&OP coordinating mechanisms were completely absent at each organization 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.

4.3. Factor reduction, model specification and model fitting

In covariance structure modeling, the practice of model modification to improve fit may lead to capitalization on chance characteristics of the data, thus raising the question of whether model modifications would generalize to other samples or to the population (MacCallum et al., 1992). To reduce the likelihood of capitalization 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 analyzed.

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 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 = Standardized 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 capitalizing on chance relationships in the data.

Table 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 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 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 Organization	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 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 – 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 Organization	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

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 behavioral 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 organizations. 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.

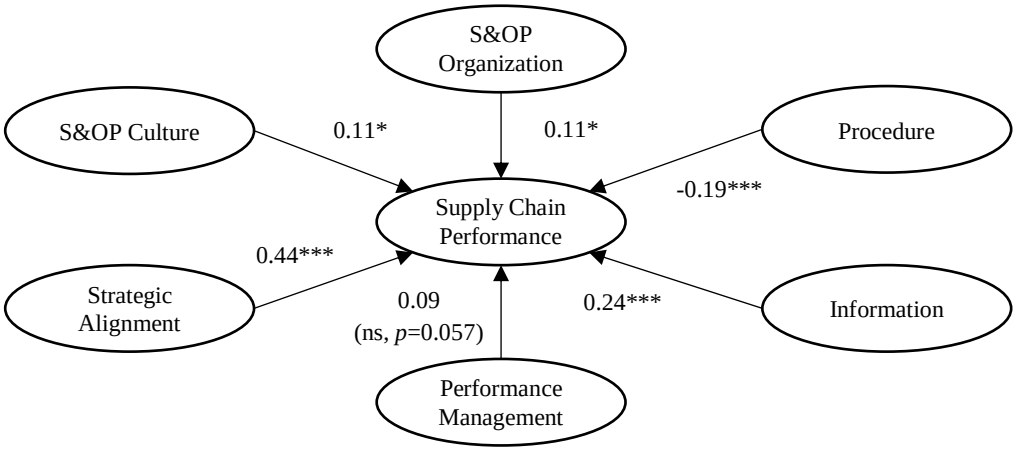
A more general problem in establishing causal models is endogeneity, in which the effect of an independent variable on a dependent variable cannot be interpreted (Antonakis et al., 2010; Ullah et al., 2018) because the model includes common-method variance, omitted causes, predictor-outcome simultaneity 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 programs could be postulated to be more likely to respond to a survey on S&OP than skeptics. 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. RESULTS

Figure 2 shows the standardized regression weights of the various S&OP constructs (***RQ1***) to Supply Chain Performance, while Table 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 2 – Structural Modeling Results (Standardized Coefficients)

Table 6 – Critical Ratios for Differences between Unstandardized Path Coefficients

Factor	**1**	**2**	**3**	**4**	**5**	**6**
1 S&OP Organization	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 Organization (***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.

5.1. Moderating effects of industry, economic maturity and region

Table 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 & defense 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 Tables 7 and 8, to investigate ***RQ3***, unstandardized coefficients *b* (instead of standardized 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 7 – Group Moderation Analysis Results for Categorical Variables

Moderator \ Hypothesis		Samples (N)	*H1* S&OP Organ-ization	*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 unstandardized 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 programs that had formal S&OP Organizations (p=0.020).and were supported by strong Performance Management (p=0.091).
- A highly formalized 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 organizations 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.

5.2. Moderating effects of firm and product characteristics

Table 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 formalized 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 organization'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 Organization 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 Organization and Supply Chain Performance (p=0.076). However, increasing firm size also significantly strengthened the negative relationship between formalized S&OP Procedure/Schedule and Supply Chain Performance (p=0.040).

Table 8 – Group Moderation Analysis Results for Ordinal Variables

Moderator \ Hypothesis		Samples (N)	*H1* S&OP Organ-ization	*H2* Procedure	*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 unstandardized regression weights (b); Significance of path coefficients: * $p<0.05$, ** $p<0.01$, *** $p<0.001$; Significance of moderating effect: # $p<0.1$, ## $p<0.05$, ### $p<0.01$

6. DISCUSSION

6.1. The links between coordinating mechanisms and supply chain performance

Our study has shown that organizations 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 unstandardized 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, organizational 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 Organization 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 emphasizing 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 organizations with "young" S&OP programs 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 socialized within the organization. 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 *socializing* 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 formalized 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&OP 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 programs 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 organization has gained more than five years' experience in S&OP.

6.2. Bricolage as a coordinating mechanism in S&OP

Our finding on the inverse effect of standardized 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 organization's design becomes increasingly complex…the effectiveness of rules as a coordinating device among departments decreases". In more unstable and uncertain environments, effective organizations are usually those that are less formalized and more reliant on mutual adjustment (Lawrence and Lorsch, 1967b). From the S&OP perspective, mature firms that practice 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, organizational bricolage (in particular reorganizing routines and reordering) may be a coordinating mechanism of effective S&OP programs, as shown in Figure 3. In conceptualizing 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 maneuvers, 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 reorganization 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 organizational 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 program 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 Organization and S&OP Culture.

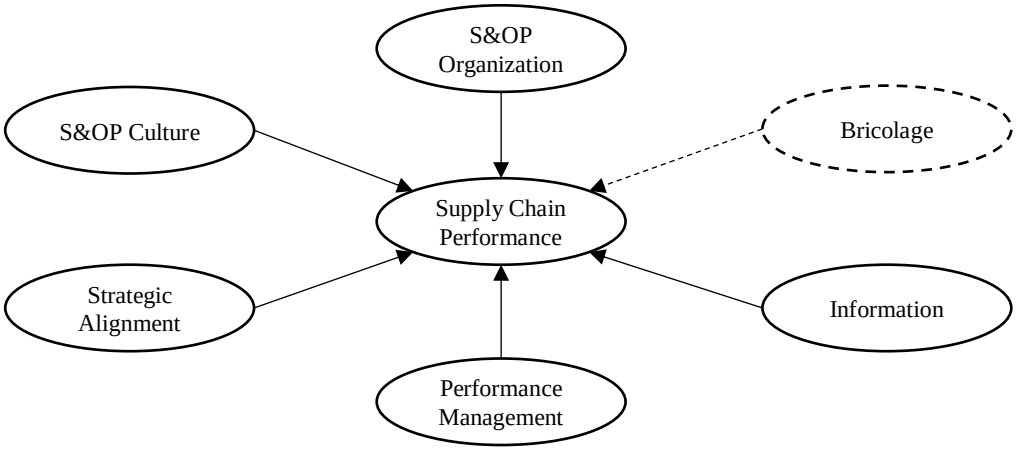


Figure 3 – Bricolage as a Coordinating Mechanism in Mature S&OP Programs

Yet, this is not to say that procedures or schedules have no place in S&OP programs. While there may be value in enforcing rules-based procedures for dysfunctional organizations 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).

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 organizations 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 organizational 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 programs from Europe and the Americas to Asia. While these managers may be accustomed to seeing strong S&OP outcomes from a strong organizational 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 Organization, 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 programs, but the specific dynamics of role shifting, reorganizing 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 organizations implementing S&OP and hence our survey sample includes a small minority of apparently "poor" specimens of S&OP programs. Nonetheless, these could potentially be the focus of a separate study on why such organizations face challenges in converting concepts of S&OP into practice, despite its formal adoption at these organizations.

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 organizations. Given the strong culture-performance link found in the literature, the weaker than expected link between S&OP Culture and Supply Chain Performance in organizations practicing S&OP is deserving of further study. Finally, the notion of a superior form of a

responsive, self-governing S&OP program that breaks away from the straitjacket of a formalized and standardized process holds great promise for future research.

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APPENDIX: CONSTRUCTS AND MEASUREMENT ITEMS

Construct	Measurement Item
Supply Chain Performance	S&OP has brought about reduced lead time to customers at your business unit
	S&OP has brought about reduced stock-outs or back-orders at your business unit
	S&OP has brought about reduced inventory at your business unit
	S&OP has brought about increased responsiveness to changes in demand at your business unit
	S&OP has brought about increased responsiveness to disruptions in supply at your business unit
S&OP Organization	There is a formal team involved in S&OP meetings
	There is a designated owner(s) for the S&OP process
	Each participant in S&OP meetings has clear roles and responsibilities
S&OP Procedure/ Schedule ("Procedure")	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
	S&OP meetings or conference calls are conducted at least once a month
Information Acquisition/ Processing ("Information")	It is easy to share, retrieve or update S&OP-related data within the organization
	S&OP is enabled by IT tools that are used in creating operational plans
	S&OP data collected is of a high standard
	S&OP data requirements are well-defined
Performance Management	S&OP performance metrics have multiple dimensions from the financial, operations or process perspectives
	Targets derived using the S&OP process is tracked against actual performance
	S&OP performance metrics balance between the interests of various parties in the organization
	Performance issues and bottlenecks are effectively addressed and followed-up upon after S&OP meetings
Strategic Alignment	S&OP supports the entering of new markets or on-boarding of new customers
	S&OP supports the coordination of new product introductions
	There is two-way feedback between strategic plans and S&OP plans
S&OP Culture	There is trust among employees or departments within the company
	Employees are empowered to contribute actively to the company's plans at various levels
	There is effective communications of business objectives and vision within the company
	Top management is supportive of S&OP