The Role of Supply Management for Sales and Operations Planning During the COVID-19 Pandemic

Dr. Martin Lockstrom
Senior Associate Professor of Operations Management
International Business School Suzhou
Xi'an Jiaotong Liverpool University
Suzhou, P.R. China
martin.lockstrom@xjtlu.edu.cn

Abstract

The aim of this paper is to examine the role of supply management for sales and operations planning (S&OP) during the COVID-19 pandemic. A deductive approach was deployed by building on a qualitative pre-study and various strands of SCM literature. All in all, eight hypotheses were derived and subsequently tested by drawing on an empirical sample collected from 130 global manufacturing firms operating in China. The data was then analyzed using partial least squares (PLS) analysis. The results indicated that business performance was positively influenced by the extent of S&OP activities, which in turn proved to be positively influenced by organizational setup, information sharing and supply management practices. The level of supply chain leadership turned out to act as antecedent to all of the three latter aforementioned.

Keywords:
Supply chain management, COVID-19 pandemic, demand planning

1. Introduction

At the end of 2019, an unknown virus first hit in Wuhan, Hubei, one of the China's biggest cities where many factories are located, with a complete city-wide lockdown lasting for ten weeks as a result (Yang et al. 2020). It subsequently spread to virtually every other country around the world in the ensuing months (Li et al. 2020). On Mar 11th 2020, it was proclaimed a pandemic by the World Health Organization (WHO) (Remuzzi & Remuzzi, 2020). With US$9.7 trillion in intermediate goods trade, constituting 52% of global trade in goods exports (WorldBank 2019)，made the global economic and trade environment even tougher and brought further implications to world trade (Haake 2020; Heiland & Ulltveit-Moe 2020; van Hoek 2021).

Many countries responded to the pandemic by closing or at least restricted their borders, cancelling flights, stopped inter-country rail transport, restricted domestic traffic and increased immigration controls (Abu-Rayash & Dincer, 2020). As a result of the pandemic restrictions, international highways became congested by passenger and transportation vehicles. Large ports around the world also began to impose pandemic countermeasures, for instance quarantine routines for workers from major outbreak countries, prohibiting ships from entering and docking, in some cases shutting down seaports completely (Saleheen & Habib 2022). Due to the restriction between countries, global supply chains became severely constricted (Guan et al. 2020; Heiland & Ulltveit-Moe 2020).

The pandemic has severely impacted supply chains across most industries, with shortages and soaring raw material prices as a result (Alsharef, Banerjee, Uddin, Albert, & Jaselskis 2021; Cai & Luo 2020; Gałaś et al., 2021). The situation has been particularly severe in e.g. the automotive industry where semiconductor shortages have caused production line stoppages for most global automotive OEMs (Ionela-Roxana, Boscoianu, Vrajitoru, & Boscoianu; Nickel & Schliebener 2021; Sawik 2020).

Considering the aforementioned, this begs the question what companies should do in order to mitigate the negative impact from the COVID-19 pandemic on their supply chains, in particular related to supply shortages. The objective of this paper is to examine and test existing theory on sales and operations planning (S&OP) within the particular context of the Chinese industry environment by analyzing empirical data collected through quantitative research methodologies. More specifically, the paper attempts to answer the following research questions in light of the COVID-19 pandemic:

- What are the antecedents to sales and operations planning (S&OP) performance?
- How does S&OP influence business performance?
- What specific role does supply management play in the context of S&OP?

2. Literature Review

This paper adheres to several existing theories relative to supply chain management and sales and operations planning (Dougherty, 2000; T. F. Wallace 2004).

2.1 Definition of Central Terms

Sales and operations planning (S&OP) is comprehensive business management approach where the management team continuously strives for emphasis, synchronization and alignment across all functions of the organization (Sheldon 2006). The S&OP concept involves updated forecasts that emanate into sales plans, production plans, inventory plans, customer lead time (backlog) plans, new product development plans, strategic plans and final financial plan (Lapide 2004; T. F. Wallace 2004). The frequency of planning activities and planning horizon depend on idiosyncratic industry conditions. As a rule of thumb, the shorter the product life cycle and the higher demand volatility, the tighter the S&OP process is required. If done properly, the S&OP process will also enable effective supply chain management (Kreuter et al. 2021).

The S&OP concept came into existence already back in the 1980s. APICS defines S&OP as the "function of setting the overall level of manufacturing output (production plan) and other activities to best satisfy the current planned levels of sales (sales plan and/or forecasts), while meeting general business objectives of profitability, productivity, competitive customer lead times, etc., as expressed in the overall business plan" (Dougherty 2000, p. 1). The key aim of the concept is to achieve production rates that helps accomplishing the company's goal of balancing supply and demand by keeping, increasing, or decreasing inventories or backlogs, ideally while keeping the headcount as stable as possible (Dougherty 2000). The planning horizon must be sufficiently long so as to facilitate planning the allocation of labor, equipment, materials, facilities and financial resources needed in order to achieve production plan targets. As the S&OP plan spans across multiple corporate functions, is requires input from functions such as purchasing, production, marketing, finance, and so forth (T. F. Wallace 2004).

S&OP has developed into a comprehensive framework in order to balance the often-conflicting objectives and trade-offs between corporate functions that are prevalent in virtually every company and industry. As such, balancing supply and demand is critical for overall operational performance of the enterprise, and one of the key sources of competitive advantage (Kreuter et al. 2021). In sum, it is increasingly considered as one of the most important ways to synchronize the internal supply chain for the purpose of improving its effectiveness and efficiency (R. Kumar & Srivastava 2008). Furthermore, it has also been described as "a set of decision-making processes to balance demand and supply, to integrate financial planning and operational planning, and to link high-level strategic plans with day-to-day operations" (T. F. Wallace 2004).

2.2 Problem Definition and Motivation of Research

The S&OP process continuously assesses customer demand and supply availability and quantitatively rebalances over a pre-determined planning horizon. The rebalancing process considers changes from the previous planning period, while helping managers to better understand how a company has achieved its extant level of performance where the key focus is on future activities and expected outcomes (Lapide 2004).

In the today's ever-changing environment, S&OP is an important framework for providing visibility across the internal supply chain. In addition to this, it also assists the decision-making process which aligns and synchronizes different functions within in the company or between companies along the supply chain. Interestingly though, in literature, S&OP models mainly focuses on inventory management, sales, and production (Affonso et al. 2008), and less on supply-side activities like purchasing. Another literature review conducted by Vereecke, Vanderheyden, Baecke, and

Van Steendam (2018) highlights the importance of supplier collaboration, but at the same time shows that there is an underemphasis on proactive and forward-looking supply management as part of the S&OP framework. This is also corroborated by anecdotal evidence through multiple interactions with practitioners who claim that purchasing activities are often at best tactical, with little long-term considerations in terms of supply availability and upstream risks.

This is further evidenced by a simple Google Trends analysis, which measures the longitudinal popularity of search for certain keywords and is widely used for forecasting and prediction in a variety of domains (Carrière-Swallow & Labbé 2013). A search for the terms "supply forecasting" and "demand forecasting", two concepts which conceptually should earn the same level of attention in any supply chain, shows that the latter garners 3-4 times as much attention as the former (Figure 1). What's even more notable is that even during the pandemic, which started in early 2020, has not led to any major uptrend in the interest for the former, potentially explaining many supply-demand imbalances experienced during the pandemic.

Nevertheless, anecdotal evidence indicates that companies that do have paid more attention to supply risks have also experienced less supply chain disruptions during the pandemic, such as Toyota which implemented an early warning system already after the Tohoku earthquake back in 2015 (Batth 2021; Matsuo 2015). Considering the supply squeezes that most, if not all companies have been facing at the time of writing, this calls for further investigation about the importance of supply management for effective S&OP, so as to better prescribe adequate actions for improving overall supply chain performance. In sum, it can be concluded that 1) supply management is underemphasized compared to demand management for at least the past decade, 2) this divergence trend has become even more exacerbated over time, and 3) companies didn't significantly increase their attention during the pandemic, hence giving testimony to a reactive approach in general across companies.

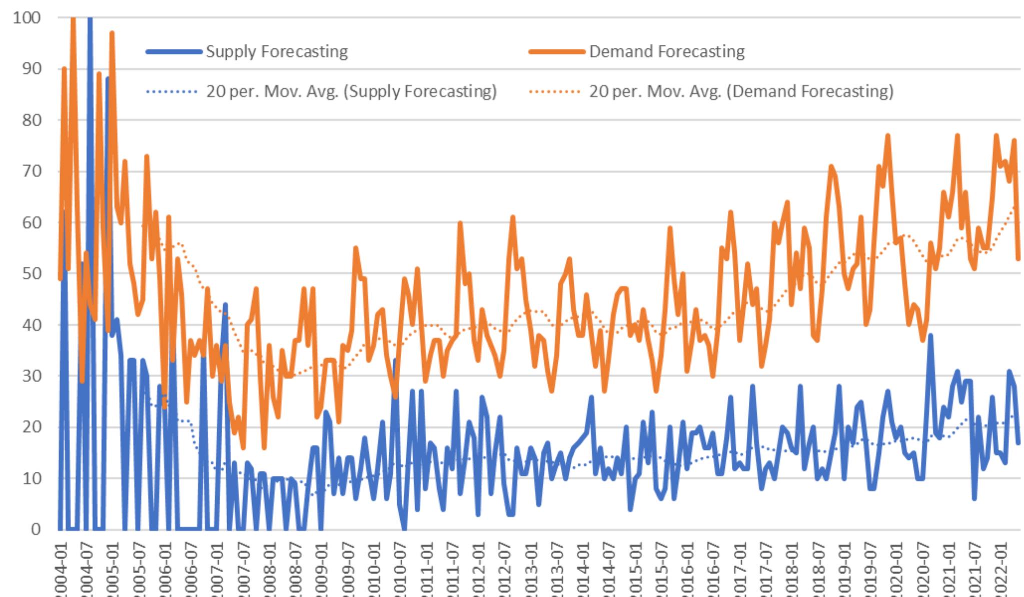

Figure 1. Google Trends analysis for the keywords "supply forecasting" and "demand forecasting".

In sum, this paper will take a novel view by more strongly emphasizing the supply side aspects of S&OP. Furthermore, as most S&OP research in the past have investigated companies operating in a relatively stable environment, this paper adds further novelty to the topic by investigating it during the COVID-19 pandemic, a period characterized by a high degree of uncertainty and market volatility.

3. Conceptual Framework and Hypotheses

For the purpose of this research, we utilize a variant of a framework as proposed by Thomé, Scavarda, Fernandez, and Scavarda (2012), which was synthesized through a meta-analysis of 271 research papers. This framework basically perceives S&OP as a process which converts inputs in the shape of plans, forecasts, operational constraints, inventory, budget and costs into outputs in the shape of marketing, sales, operations and finance plans (Thomé et al. 2012). Furthermore, the process is influenced by the corporate strategic plan which in turn is influenced by the business plan. Despite its rigor and comprehensiveness, the underlying meta-analysis indicates a clear over-emphasis on demand-side planning activities, where supply-side activities like purchasing is barely mentioned at all; conceptually, this is instead being incorporated into the activity category referred to as "operations".

In terms of performance implications of S&OP, Feng, D'Amours, and Beauregard (2008) utilized a mixed integer-based programming model which showed that completely integrated S&OP frameworks yield higher financial returns than a partially integrated or decoupled planning process. Research by Selldin and Olhager (2007) showed that S&OP and master planning act as mediators between business uncertainty and the financial performance. Furthermore, Nakano (2009) identified a positive linkage between internal and external alignment the effects from this on performance. What's more, Hadaya and Cassivi (2007) identified a positive relationship between information systems and collaboration on business performance. In addition, research by McCormack and Lockamy (2005) concluded that there was a positive effect from formal groups, informal organization, integration, and network formation on business performance. Finally, Oliva and Watson (2011) showed in a case study that business performance is improved by the existence of an effective S&OP process even in the case of conflicting incentives and rewards in the supply chain. For the purpose of this study, we separate business performance into two constructs, namely strategic performance and financial performance. Having said the above, we define the first set of hypotheses as follows:

H1a. Sales and operations planning has a positive impact on strategic performance.
H1b. Sales and operations planning has a positive impact on financial performance.

In terms of antecedents to sales and operations planning, Thomé et al. (2012, p. 5) conceptualizes the process itself to comprise three main activities, namely "meetings and collaboration", "organization", and "information technology". For the purpose of this paper, it is understood that meetings and collaboration is conceptually part of the organization construct in a sense that it both represents "what the company is having", as well as "what the company is doing". Implementation of a formal S&OP process and formation of a formal S&OP team have been shown to be pivotal for high process performance (Lapide 2004, 2005a, 2005b; Piechule 2008; Singh 2010; Whisenant 2006). Considering the importance of embedding S&OP in an adequate organization, we hypothesize the following:

H2a. Supply chain organization has a positive impact on sales and operations planning.

Another key success factor of supply chain management that has been repeatedly pointed out is information sharing. As (Lee, Padmanabhan, & Whang, 1997, p. 546) points out, it is a "basic enabler for tight coordination is information sharing, which has been greatly facilitated by the advances in information technology". Further theoretical models by (Lee, So, & Tang 2000) corroborates this view. Marshall (2015) continues along this line by demonstrating through a meta-analysis how information sharing leads to strategic changes between manufacturers and suppliers. Sanders and Premus (2002) demonstrate that "improve communication, enable effective decision making, acquire and transmit data, and enhance performance of the supply chain". Furthermore, it has been repeatedly proven that supply chain information sharing can have positive impact on supply chain performance in terms of better customer service (Huang & Gangopadhyay 2004); Lee and Whang (2000). From a process point of view, information technology has been shown to be a key enabler (Lapide, 2005a), even though some scholars argue that simple solutions like spreadsheets can be used for monitoring and controlling in the initial implementation phase (Grimson & Pyke 2007; T. Wallace & Stahl, 2008). Furthermore, Feng et al. (2008) discussed the use of mathematical models and simulation techniques in order to balance supply and demand in an optimal fashion. Finally, Affonso et al. (2008), Ivert Kjellsdotter and Jonsson (2014), and Chen-Ritzo, Ervolina, Harrison, and Gupta (2010) have also stressed the importance of advanced planning and scheduling systems (APS) in S&OP. As a consequence, the following hypothesis is defined:

H2b. Supply chain information management has a positive impact on sales and operations planning.

Despite not having a very prominent place in S&OP, it is commonly known from the domain of supply chain management, as well as from anecdotal evidence and past research that *supply management* plays an important role in for effective supply chain management (Lockström & Lei 2013; M. Lockström, J. Schadel, N. Harrison, R. Moser, & M. K. Malhotra, 2010; T. F. Wallace 2004). Davidsson and Hansson (2019) describes through a case study how purchasing can be integrated with the S&OP framework. A few authors have described S&OP frameworks where procurement should be part of cross-functional collaboration (Feng et al. 2008; Nabil, El Barkany, & El Khalfi 2018), however there are no known studies where causal linkages to or from it has been previously examined. With that in mind, we develop the following hypothesis:

H2c. Supply management has a positive impact on sales and operations planning.

Literature is replete with studies that highlight the importance of leadership as the primordial antecedent to effective supply chain management. Through a meta-analysis, Mokhtar, Genovese, Brint, and Kumar (2019) identified 51 influential studies from top-tier journals that investigates the topic. Significant and positive linkage between leadership and various supply chain related factors have been verified in the past (Lockström & Lei 2013; M. Lockström, J. Schadel, N. Harrison, R. Moser, & M. Malhotra 2010). As of today, most leadership research has usually been centered on "influencing a group of people to achieve a common goal" within a single focal organization (Northouse, 1997, p. 3) by utilizing formal power and authority (French & Raven 1959). Although the concept of supply chain leadership is generally perceived to span firm boundaries (Lockström & Lei, 2013; Martin Lockström et al., 2010), this study specifically examines the influence of leadership within one's own organization. In order to carry out effective S&OP, adequate supply of raw materials have to be ensured. As power in any organization for the most part emanates from top down, it is clear that leadership plays a pivotal role for managerial activity; this also applies to the domain of supply chain management, including the three aforementioned areas pertaining to S&OP. As a result, we propose the following set of hypotheses:

H3a. Leadership has a positive influence on the supply chain organization.
H3b. Leadership has a positive influence on supply chain information management.
H3c. Leadership has a positive influence on supply management.

As a result, this leads to the following conceptual framework as shown in Figure 2.

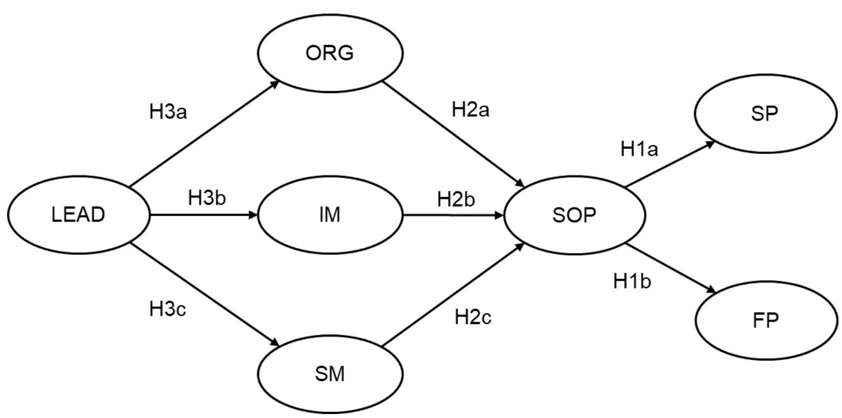

Figure 2. Conceptual framework with hypotheses.

4. Methodology

The model shown in Figure 2 was tested by collecting empirical quantitative data through online survey methodology. The sample domain of the research mainly consisted of middle and upper managers from large-sized companies with operations in China, for instance general managers, functional heads, directors, but also c-level executives. The pre-study indicated that these categories of professionals are commonly involved in supply chain and operations functions within the enterprise. As a result, these categories of informants were considered the most qualified or inclusion in the research, hence minimizing the risk of key-informant bias (N. Kumar et al. 1993). An annual revenue exceeding US$5B was set as a qualifying criterion for participation in the study.

As a first step, a contact database consisting of 1,308 entries of companies with operations in China was prepared. As a second step, the contacts in this database were sent an invitation e-mail to complete the online questionnaire. The invitation contained a hyperlink through which participants could access survey in the shape of an online questionnaire. 286 invitations bounced back and the corresponding contacts were hence invalid. This is a normal phenomenon as people change jobs over time, hence rendering e-mail addresses increasingly invalid as time goes by. This phenomenon is particularly prevalent in China as the average job turnover rate is still a double-digit percent (Xu 2010).

A total number of 143 questionnaires were completed, thus yielding an initial response rate of 14.0 percent. Out of these, 72 questionnaires were only partially filled out. 25 were still deemed sufficiently useful, rendering a final total of 96 useable questionnaires. One week after the first e-mail invitation round, non-respondents were contacted via telephone and a follow-up e-mail and asked to complete the online questionnaire. In order to safeguard proper information gathering, the phone calls were conducted by a native Chinese-speaking research assistant. Through this effort, a total of 118 phone calls were satisfactorily made, rendering another 42 completed questionnaires. 8 of these were again only partially completed, making the remaining 34 useable.

As a result, a final tally of 130 usable questionnaires were finally attained, corresponding to an effective response rate of 11.4 percent, which is modestly lower compared to mail surveys but are not considered any problem as pointed out previously through past research (Fitti, 1979; Massey et al. 1981). The achieved response rate is also in line with levels observed in empirical studies from the past (Banker, Bardhan, Chang, & Lin, 2006; Ray, Muhanna, & Barney, 2001); the challenge to achieve adequate response rates is even more prevalent in China as local companies are usually highly concerned about confidentiality and data protection. The sample comprised a broad array of industries, distributed as depicted in Table 2. The industries correspond to SIC codes 07, 17, 28, 34, 35, 36, 37, 47, 48 and 55. For this paper, only manufacturing industries were involved, intentionally focusing on those with a significant degree of import and export activities such as machinery and automotive.

Table 1. Country of origin.

Country	**#Companies**	**Percentage**
United States	22	17
Germany	20	15
United Kingdom	16	12
Netherlands	8	6
China	7	5
Japan	3	2
Korea	3	2
Italy	8	6
France	8	6
Spain	7	5
Brazil	3	2
Mexico	4	3
Canada	4	3
Other	17	16
Total	130	100

As can be seen from Table 1, most companies were from western countries such as Germany, USA and UK, accounting for forty percent of the total sample. In terms of industry representation, machinery, electronics, energy and retail comprise 50% of the total sample (Table 2).

Table 2. Industry representation

Industry	**#Companies**	**Percentage**
Machinery	22	17

Electronics	20	15
Energy	14	11
Retail	9	7
Transportation	8	6
Chemical	8	6
Agriculture	4	3
Financial services	4	3
Construction	4	3
Communications	1	1
Others	36	28
Total	130	100

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Approximately 24 percent of the completed questionnaires were obtained via the follow-up call; this classification was utilized in order to examine potential non-response bias. In order to verify this, a variant of the approach as suggested by Armstrong and Overton (1977) was utilized. Questionnaires from the initial phase were compared to the respondent group from the follow-up calls on three nominal variables, in this case relative sales growth, return on assets and market share (Lockström & Lei, 2013). The premise of this analysis was that follow-up call responses shares the same qualities and response biases compared to those of non-responses. A chi-square test was conducted which didn't indicate any significant differences between first-round online respondents and follow-up call respondents for the variables comparative sales growth ($\chi^2_{5df} = 3.27$, $p = 0.66$), return on assets ($\chi^2_{5df} = 6.55$, $p = 0.26$) or industry ($\chi^2_{5df} = 4.35$, $p = 0.50$). In other words, no evidence of obvious response bias in the sample appeared to be present. Even though there are more rigorous non-response bias tests available (Mentzer & Flint 1997), this one was deemed fit for purpose for this particular research.

5. Analysis and Results

In this section, the empirical data collection and corresponding results from the analysis is explained. In terms of methodology, the analysis process was divided into two parts. In the first phase, the measurement model was evaluated, after which validation of the structural model itself followed.

5.1 Measurement Model

For this research, an procedure as proposed by Jarvis, MacKenzie, and Podsakoff (2003) was applied. In case of uncertainty, extant theory, constructs defined in the past, and the pre-study were utilized to optimally operationalize the constructs (Barclay, Higgins, & Thompson, 1995; Chin & Gopal, 1995; John Hulland, 1999). As the latent variables measure beliefs and attitudes of respondents, they should preferably be operationalized through reflective item indicators (Coltman et al. 2008). Put differently, the constructs can be perceived as encompassing latent variables where construct items represent a common theme and hence are correlated. The constructs along with corresponding items are shown in Table 3. Every question was derived from pertinent literature so as to safeguard content validity and these were also confirmed through prior expert interviews so as to ensure face validity.

Table 3. Definitions of latent variables and corresponding construct items.

Latent Variable	**Item Code**	**Item Scale Measurement**
Supply chain leadership (LEAD)	LEAD1	We extensively involve senior management in the sales and operations planning process.
	LEAD2	We extensively involve senior management in the demand planning process.
	LEAD3	We extensively involve senior management in supply planning process.
	LEAD4	We extensively involve senior management in supply chain execution activities.
Supply chain organization (ORG)	ORG1	Most corporate functions are involved in cross-functional S&OP collaboration initiatives.
	ORG2	Our staff have the right level of competencies and skills to effectively carry out S&OP activities.
	ORG3	S&OP related KPIs are part of our employees' individual performance assessment
	ORG4	We have a formal S&OP taskforce existing in our organization.
Information management (IM)	IM1	We frequently receive and share supply chain related information with partners.
	IM2	We extensively use IT tools and techniques to support information sharing.

	IM3	We use objective data in our supply chain planning process.
	IM4	We use multiple data sources in our supply chain planning process.
	IM5	We continuously strive to improve information sharing.
	IM6	We take corrective action when necessary to improve information sharing.
Supply management (SM)	SM1	We actively categorize our suppliers based on strategic impact and supply market risks
	SM2	We extensively collaborate with suppliers in order to gain better insight in future supply availability.
	SM3	We continuously identify and evaluate upstream supply chain risks and/or other potential bottlenecks.
	SM4	We strive to ensure availability of supply (e.g. backup suppliers, multiple sourcing etc.)
Sales and operations planning (SOP)	SOP1	We apply IT tools and/or other techniques to effectively balance supply and demand.
	SOP2	We apply IT tools and techniques for supply planning purposes.
	SOP3	We apply IT tools and techniques for demand planning purposes.
	SOP4	We involve supply planning in S&OP processes.
	SOP5	We involve demand planning in S&OP processes.
	SOP6	We continuously and actively develop/deploy formal S&OP plans which considers both supply and demand factors.
	SOP7	We continuously do long-term demand planning.
	SOP8	We continuously do short-term demand planning.
Strategic performance (SP)	SP1	We are among the top three competitors over the past three years in terms of sales growth.
	SP2	We are among the top three competitors over the past three years in terms of market share.
Financial performance (FP)	FP1	We are among the top three competitors over the past three years in terms of pre-tax profitability (EBIT).
	FP2	We are among the top three competitors over the past three years in terms of return on assets (ROA).

A factor analysis was conducted in order to ensure convergent validity. The results indicated that all construct items loaded significantly onto the respective constructs, with a few exceptions, namely SOP6-8, IM6 and LEAD4, however these turned out to pose no problem when applying PLS as is shown in the following; hence convergent validity was deemed adequate on the whole (Table 4). The resulting constructs were subsequently applied using PLS modeling.

Table 4. Factor analysis results. Extraction Method: Principal Axis Factoring. Rotation Method: Equamax with Kaiser Normalization. Rotation converged in 13 iterations.

Construct Item	Factor						
	1	2	3	4	5	6	7
SOP1	**.772**	.080	.280	.251	.152	.066	.247
SOP2	**.594**	.084	.071	.131	.372	.375	.084
SOP3	**.592**	.075	.018	.141	.217	.253	-.002
SOP4	**.590**	.208	.307	.147	.231	.107	.117
SOP5	**.579**	.229	.181	.252	.184	.064	.218
SOP6*	**.251**	.136	.025	.015	.219	.188	.149
SOP7*	**.340**	.210	.056	.135	.310	.131	.120
SOP8*	**.323**	-.007	.209	.275	.141	.116	.189
IM1	.182	**.811**	.150	-.024	.122	.194	-.007
IM2	.154	**.800**	.309	.027	.087	-.002	.060
IM3	.001	**.636**	-.077	.105	-.036	.063	.228
IM4	-.053	**.539**	-.247	.230	-.088	.042	.401
IM5	-.164	**.506**	.229	.472	-.027	.139	.035
IM6*	.298	**.498**	.139	.113	.117	-.057	.176
ORG1	.276	-.004	**.790**	.037	.118	.078	.169
ORG2	.050	.180	**.708**	.101	-.048	.217	.092
ORG3	.072	.147	**.635**	.067	.036	.280	.064
ORG4	.147	.088	**.567**	.198	.400	-.101	-.049
SM1	.220	-.075	.034	**.767**	.041	.073	.017
SM2	.088	.203	.102	**.733**	.075	-.073	.061
SM3	.049	.039	-.047	**.669**	-.082	.143	.254

SM4	.348	.063	.237	**.601**	.214	.109	-.002
LEAD1	.171	.040	-.070	.052	**.811**	.230	.090
LEAD2	.124	.064	-.029	.028	**.727**	.222	.178
LEAD3	.009	-.064	.496	-.129	**.648**	.022	.058
LEAD4*	.102	.385	.433	.142	**.386**	.207	.013
FP1	-.033	-.003	.178	.134	.138	**.809**	.177
FP2	.118	.067	.054	-.065	.140	**.762**	.431
SP1	-.058	.026	.121	.147	.144	.185	**.803**
SP2	.261	.063	.065	-.119	-.026	.431	**.685**

As a subsequent step, Cronbach's alpha and the Fornell and Larcker (1981) measure of internal consistency for each of the constructs were calculate in order to validate construct reliability. As shown in Table 5, all the respective values were significantly above the threshold of 0.70 as proposed by (Nunally 1978). Furthermore, factor loadings (>0.50) and statistical significance of construct item loadings were assessed in order to verify convergent validity, as suggested by Falk and Miller (1992). In addition, average variance extracted (AVE), should also be above the threshold value of 0.50 (Barclay et al. 1995). As shown in Table 5, all these criteria were fulfilled and surpassed by a wide margin.

Table 5. Measurement model specification.

Construct name	**Construct items**	**Factor loadings**	**t-values**	**AVE**	**Cronbach's alpha**	**Composite reliability**
LEAD	LEAD1	0.88	13.7	0.72	0.79	0.98
	LEAD2	0.89	11.8			
	LEAD3	0.92	12.4			
	LEAD4	0.68	3.80			
ORG	ORG1	0.96	59.3	0.92	0.84	1.00
	ORG2	0.96	45.7			
	ORG3	0.95	52.8			
	ORG4	0.96	71.0			
IM	IM1	0.90	16.4	0.73	0.84	0.98
	IM2	0.89	13.0			
	IM3	0.93	30.2			
	IM4	0.92	21.1			
	IM5	0.72	3.60			
	IM6	0.74	4.05			
SM	SM1	0.95	41.0	0.92	0.82	1.00
	SM2	0.96	31.4			
	SM3	0.96	39.1			
	SM4	0.95	29.4			
SOP	SOP1	0.87	21.3	0.82	0.93	0.99
	SOP2	0.92	32.1			
	SOP3	0.89	11.1			
	SOP4	0.91	12.1			
	SOP5	0.92	25.5			
	SOP6	0.87	19.5			
	SOP7	0.90	11.5			
	SOP8	0.91	9.24			
SP	SP1	0.98	138	0.93	0.84	1.00
	SP2	0.98	136			
FP	FP1	0.96	52.6	0.97	0.77	1.00
	FP2	0.97	80.4			

In the final step, discriminant validity was assessed by comparing the square root of latent variable average variance extracted (AVE) with latent variable correlations (Table 6). The correlation matrix showed that the square root of AVE was greater than the off-diagonal values except for one (SOP vs. LEAD; 0.91 vs. 0.95 respectively), which provides evidence of discriminate validity (J. Hulland et al. 1995). However, the difference the difference was not big enough to cause overall concern.

Table 6. Latent variable correlation matrix.

No.	Construct	Mean	σ	√AVE	1	2	3	4	5	6	7
1	LEAD	3.55	0.97	0.85	1.00						
2	ORG	3.48	0.75	0.96	0.55	1.00					
3	IM	3.23	0.88	0.85	0.67	0.80	1.00				
4	SM	3.71	0.65	0.96	0.85	0.61	0.71	1.00			
5	SOP	3.47	0.88	0.91	0.95	0.56	0.67	0.83	1.00		
6	SP	3.23	0.86	0.96	0.67	0.81	0.92	0.75	0.71	1.00	
7	FP	3.18	0.74	0.98	0.69	0.73	0.84	0.74	0.66	0.85	1.00

5.2 Structural Model

The software SmartPLS 13.0 was used to evaluate the structural model (Sarstedt et al. 2017). Partial least squares regression is a suitable statistical methodology since it does not assume normally distributed data, it is insensitive to multicollinearity, and performs well under conditions where the number of indicator variables is large in comparison compared to the sample size (Abdi 2003). As PLS is a components-based structural equations modeling technique, PLS is similar to regression, however it also concurrently models the structural paths (i.e., theoretical relationships between constructs) as well as the measurement paths (i.e. relationships between a construct and its item variables). Instead of assuming the same weights for all indicators of a scale, the PLS algorithm enables each indicator to dynamically adjust the composite score contribution of the latent variable. Therefore, lower weightings are assigned to construct items with weaker relationships to related indicators and the latent construct. In that sense, PLS is superior to techniques such as regression as the latter assume error free measurement (Lohmöller 1989; Wold 1975, 1980 1985).

Concerning minimum sample size, an procedure proposed by Cohen and Cohen (1983) was utilized. It involves computing the minimum sample size for each construct in separation by computing their corresponding squared multiple correlations (R^2) and the associated number of paths leading to each one of them. After choosing the most common significance level of 0.05 and the ideal statistical power level of 0.8, the minimum sample size is obtained through the largest of this set of numbers calculated. In hindsight, the minimum sample size turned out to be 124, which is achieved by margin with an actual sample size of 130 in this case.

The latent variables ORG, IM and SM proved to be positively influenced by LEAD, with corresponding amounts of variance explained at 51.0, 63.5 and 71.2 percent, respectively. All three paths were significant at the 0.1 percent level, and the corresponding path coefficients were 0.71, 0.80 and 0.84 respectively. Consequently, hypotheses H3a-c were all accepted. The latent variable SOP proved to be significantly and positively influenced by LEAD, IM and SOP, with path coefficients of 0.21, 0.37 and 0.42, respectively. A total of 82% of its variance was explained by the three constructs. Hence, hypotheses 2a-c were accepted. SOP in turn proved to positively and significantly influence both SP and FP at the 0.1 percent level, with path coefficients of 0.71 and 0.67, respectively. The variance explained by it were 49.7 and 44.9 percent, respectively. Consequently, hypotheses 1a-c were accepted. A summary of the hypothesis testing is shown in Table 7.

Table 7. Path coefficients of structural model

Hypothesis	Path	Path Coefficient	Standard Error	t-value
H1a	SOP→FP	0.71***	0.084	8.4
H1b	SOP→SP	0.67***	0.13	3.15
H2a	ORG→SOP	0.21*	0.059	14.2
H2b	IM→SOP	0.37**	0.091	2.36
H2c	SM→SOP	0.42**	0.099	6.79

H3a	LEAD→ORG	0.71***	0.12	3.03
H3b	LEAD→IM	0.80***	0.1	7.7
H3c	LEAD→SM	0.84***	0.097	7.36

.

In sum, all eight hypotheses postulated were accepted. With this in mind, the overall validity of the model can be considered very high. A graphic illustration of the structural model can be seen in Figure 3.

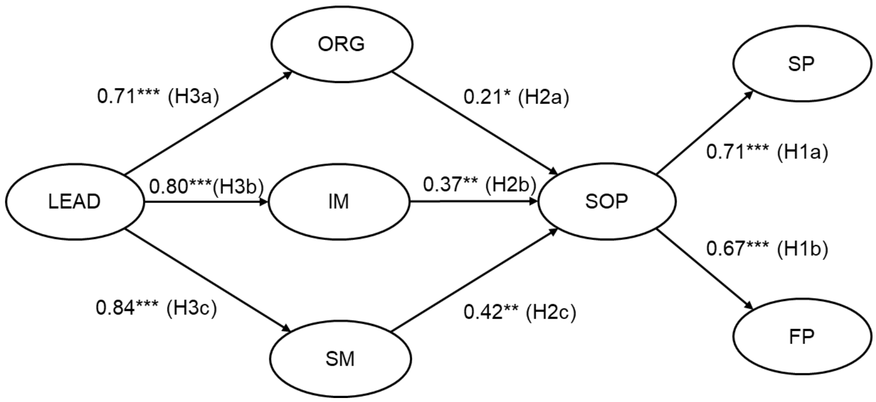

Figure 3. Structural model with path coefficients, construct variance explained and significance levels. * Significant at the 0.05 level. ** Significant at the 0.01 level. *** Significant at the 0.001 level. — Insignificant path.

6. Conclusions

Virtually every company around the world has been affected by the COVID-19 pandemic to more or less extent. Having said that, it is of importance for companies to learn from the past and better understand how to effectively mitigate effects from it, but also in order to be better prepared for similar adverse macro events in the future. In this section, contributions to theory and implications for managers are discussed.

6.1 Theoretical Contributions

This study examined antecedents to sales and operations planning and the effects corresponding impact on business performance. The result from the study supports hypothesized causal linkages related to S&OP in terms of leadership, organization, information management, and supply management on sales and operations planning, and in turn the effects on business performance. The results were in line with expectations where all hypotheses were accepted at high significance levels. Overall, the outcome provides insight into the causes and effects of S&OP under highly rare and idiosyncratic conditions in terms of the COVID-19 pandemic.

As most companies have adjusted their supply chains according to a long period of relative stability ever since the global financial crisis (GFC) back in 2008, they have literally been taken with their pants down as the Sino-US trade war struck in 2018, followed by the COVID-19 pandemic in early 2020. More specifically, referring to the supply chain design framework proposed by Lee et al. (1997), it's becoming increasingly evident that companies during this period opted for an "efficient" supply chain design which is characterized by focus on efficiency, low cost, zero-inventory policy, just-in-time (JIT) delivery, and similar things. As such, it is becoming increasingly clear that management concepts like "lean" is not a panacea, and it should be understood that it's not ideal under all conditions. As a consequence, companies need to build "higher-order" S&OP capabilities in order to re-configure supply their supply chains as the environment changes – in other words, having the ability to rapidly transition from an "efficient" supply chain to an "agile" one when the situation calls for it. In sum, this insight provides a novel perspective on exiting supply chain theories related to S&OP.

6.2 Managerial Implications

COVID-19 has exposed weaknesses of the global supply chains to disruptions and as a consequence a potential overreliance on China for sourcing and manufacturing (Javorcik & work, 2020). Some scholars, like Shih (2020) argues that it is time to start rethink the concept of global supply chains. As supply chains have been severely affected by the COVID-19 pandemic in terms of delays, disruptions and soaring raw material prices, companies need ways to mitigate the impact both today but also for the future. As described in section 7.1, conduct periodic assessment of both the external environment and one's own supply chain so as to ensure that there's a strategic fit between the two. Ideally, this exercise should be forward-looking, in order to promote a proactive rather than a reactive approach, as the latter usually implies addressing problems when it's already too late. As the S&OP framework has predominantly emphasized demand-side activities, this research shows highlights the equal importance of supply-side activities in order to achieve optimal supply chain performance.

In concrete terms, this means continuous screening for internal and external supply chain risks, overall assessment of supply and demand uncertainty, with corresponding adjustments of sourcing strategies, inventory policies etc., as a result. For instance, anecdotal evidence shows that many companies have misunderstood the concept of "lean", erroneously believing that the goal should be minimization or even elimination of inventory, whereas in fact the correct approach is optimization of inventory levels. Such a small shift in paradigm means that there will be sufficient leeway and ability to justify inventory increases during periods of high uncertainty, and reduction of inventory during periods of low uncertainty.

What this means from a supply management perspective is that companies have to enable the ability to dynamically shift between the prevalent "Just-In-Time" (JIT) and the less applied "Just-In-Case" (JIC) philosophies. In addition to adjustment of inventory levels, this means adjusting a number of supply chain design parameters. First, companies need to properly segment their supplier base according to their strategic importance and structure their relationships accordingly (Kraljic, 1983). For strategic and bottleneck suppliers, this might imply increasing the number of active suppliers per category, or at least qualify backup suppliers. Second, from a risk mitigation point of view, companies should also assess the geographic dispersion of suppliers and make sure they aren't too concentrated to a single region; over the years, it has become clear that many companies have become over-reliant on countries like China. Third, from an information sharing point of view, companies should also set up early warning systems, where information in the form of alerts are forwarded not only from first-tier suppliers, but also from lower-tier suppliers, thereby increasing timeliness and accuracy of information. Toyota did this years ago as a result from the Fukushima nuclear disaster and managed to go relatively unscathed during the automotive semiconductor shortage during the pandemic (Davis 2021). Fourth, agile product development techniques which enables rapid product reconfiguration can enable "designing away" serious supply bottlenecks on a relatively short notice (de Raedemaecker, Handscomb, Jautelat, Rodriguez, & Wienke 2020).

To conclude, the ultimate competitive advantage of a business is its ability to adapt to a changing environment; companies that fail to do this, will see the same fate as the dinosaurs once did, namely going extinct. As supply chains play a pivotal role for most businesses, they're truly one of the key success factors in this context.

6.3 Limitations and Suggestions for Future Research

As this is a cross-sectional research project, as a consequence, the results only offer a snapshot picture of the pertinent situation. Therefore, it does not consider the fast-changing nature of production and sourcing markets in developing countries such as China. As a supplement to cross-sectional studies, a longitudinal follow-up study could also add further rigor to the arguments about causality. What's more, considering the fairly small sample size, it was not feasible to conduct cross-industry comparisons. On the other hand, this provides opportunities for future research so as to identify and analyze industry-specific differences and similarities. Finally, the specific conditions of the Chinese industry impedes the generalizability of the conceptual framework to other geographical regions. Nevertheless, this study is an important step for the development of conceptual frameworks for quickly developing economies and industry sectors.

7. References

Abdi, H. , Partial Least Squares Regression. In M. Lewis-Beck, A. Bryman, & T. Futing (Eds.), *Encyclopedia of Social Sciences Research Methods 2003*. Thousand Oaks, CA: Sage Publications.

Abu-Rayash, A., & Dincer, I., Analysis of mobility trends during the COVID-19 coronavirus pandemic: Exploring the impacts on global aviation and travel in selected cities. *Energy research social science, 68*, 101693, 2020.

Affonso, R., Marcotte, F., & Grabot, B., Sales and operations planning: the supply chain pillar. *Journal of Production Planning, 19*(2), 132-141, 2008.

Alsharef, A., Banerjee, S., Uddin, S., Albert, A., & Jaselskis, E., Early impacts of the COVID-19 pandemic on the United States construction industry. *International journal of environmental research public health, 18*(4), 1559, 2021.

Armstrong, J. S., & Overton, T. S., Estimating nonresponse bias in mail surveys. *Journal of marketing Research, 51*(14), 396-402,1977.

Banker, R. D., Bardhan, E. R., Chang, H., & Lin, S., Plant information systems manufacturing capabilities and plant performance. *MIS Quarterly, 30*(2), 315-337,2006.

Barclay, D., Higgins, C., & Thompson, R., The partial least squares (PLS) approach to causal modeling: personal computer adoption and use as an illustration. *Technology studies, 2*(2), 285-309, 1995. doi:citeulike-article-id:5760069

Batth, V., Toyota Motor Corporation: Just in Time (JIT) Management Strategy or Beyond? *Journal of Case Research, 12*(1), 2021.

Cai, M., & Luo, J. J. J. o. S. J. U. , Influence of COVID-19 on manufacturing industry and corresponding countermeasures from supply chain perspective. *25*(4), 409-416, 2020.

Carrière‐Swallow, Y., & Labbé, F. J. J. o. F., Nowcasting with Google Trends in an emerging market. *32*(4), 289-298, 2013.

Chen-Ritzo, C.-H., Ervolina, T., Harrison, T. P., & Gupta, B., Sales and operations planning in systems with order configuration uncertainty. *European Journal of Operational Research, 205*(3), 604-614,2010.

Chin, W. W., & Gopal, A. , Adopting intention in GSS: relative importance of beliefs. *Data Base, 26*(2/3), 42-63, 1995.

Cohen, J., & Cohen, P. (1983). *Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences* (2 ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, 1983.

Coltman, T., Devinney, T. M., Midgley, D. F., & Venaik, S. , Formative versus reflective measurement models: two applications of formative measurement. *Journal of Business Research, 61*(12), 1250-1262, 2008.

Davidsson, M., & Hansson, F. (2019). How to Integrate Purchasing with the Sales and Operations Planning Process.

Davis, R. (2021). How Toyota Steered Clear of the Chip Shortage Mess. *Bloomberg, 2019*.

de Raedemaecker, S., Handscomb, C., Jautelat, S., Rodriguez, M., & Wienke, L. (, Lean management or agile? The right answer may be both. *McKinsey Quarterly, June 2020,*

Dougherty, J. R. J. A. M. P. o. R. R. (2000). Getting Started with Sales & Operations Planning. 24.

Falk, R. F., & Miller, N. B. (1992). *A primer for soft modeling*: University of Akron Press.

Feng, Y., D'Amours, S., & Beauregard, R., The value of sales and operations planning in oriented strand board industry with make-to-order manufacturing system: Cross functional integration under deterministic demand and spot market recourse. *International Journal of Production Economics, 115*(1), 189-209, 2008.

Fitti, J. E., Some results from the Telephone Health Interview Survey. In *Proceedings of the American Statistical Association* (pp. 244-249), 1979.

Fornell, C., & Larcker, D. F. , Structural equation models with unobservable variables and measurement error: Algebra and statistics. In: Sage Publications Sage CA: Los Angeles, CA., 1081

French, J., & Raven, B. H. (1959). The bases of social power. In D. Cartwright (Ed.), *Studies of Social Power* (pp. 150-167). Ann Arbor, MI: Institute for Social Research.

Gałaś, A., Kot-Niewiadomska, A., Czerw, H., Simić, V., Tost, M., Wårell, L., & Gałaś, S. J. R. , . Impact of Covid-19 on the Mining Sector and Raw Materials Security in Selected European Countries. *10*(5), 39, 2021.

Grimson, J. A., & Pyke, D. F. (2007). Sales and operations planning: an exploratory study and framework. *The International Journal of Logistics Management*.

Guan, D., Wang, D., Hallegatte, S., Davis, S. J., Huo, J., Li, S., . . . Coffman, D. M., Global supply-chain effects of COVID-19 control measures. *Nature human behaviour, 4*(6), 577-587, 2020.

Haake, D. (2020). Covid-19: impacts on freight transportation. *Institute of Transportation Engineers. ITE Journal, 90*(11), 46-46, 2020.

Hadaya, P., & Cassivi, L., The role of joint collaboration planning actions in a demand-driven supply chain. *Industrial Management Data Systems, 2007*.

Heiland, I., & Ulltveit-Moe, K. H., 11 An unintended crisis is sea transportation due to COVID-19 restrictions. *COVID-19 Trade Policy: Why Turning Inward Won't Work*, 151, 2020.

Huang, Z., & Gangopadhyay, A., A simulation study of supply chain management to measure the impact of information sharing. *Information Resources Management Journal, 17*(3), 20-31, 2004.

Hulland, J., Use of partial least squares (PLS) in strategic management research: a review of four recent studies. *Strategic Management Journal, 20*(2), 195-204, 1999.

Hulland, J., Chow, Y. H., & Lam, S. , Use of Causal Models in Marketing Research: A Review. *International Journal of Research in Marketing, 13*(1), 181-197, 1995.

Ionela-Roxana, P., Boscoianu, M., Vrajitoru, E.-S., & Boscoianu, E.-C. Procurement in Automotive Industry.

Ivert Kjellsdotter, L., & Jonsson, P. (2014). When should advanced planning and scheduling systems be used in sales and operations planning? *International Journal of Operations Production Management, 34*(10), 1338-1362.

Jarvis, C. B., MacKenzie, S. B., & Podsakoff, P. M., A critical review of construct indicators and measurement model misspecification in marketing and consumer research. *Journal of Consumer Research, 30*(2), 199-218, 2003.

Javorcik, B. J. C.-., & work, t. p. W. t. i. w. t., Global supply chains will not be the same in the post-COVID-19 world. *111, 2020*.

Kraljic, P. (1983). Purchasing Must Become Supply Management. *Harvard Business Review, 61*(5), 109-117.

Kreuter, T., Scavarda, L. F., Thomé, A. M. T., Hellingrath, B., & Seeling, M. X. , Empirical and theoretical perspectives in sales and operations planning. *Review of Managerial Science*, 1-36, 2021.

Kumar, N., Stern, L. W., & Anderson, J. C., Conducting Interorganizational Research Using Key Informants. *Academy of Management Journal, 36*(6), 1633-1651, 1993.

Kumar, R., & Srivastava, S. K., *Towards Improving the Sales & Operations Planning Process.* Paper presented at the Proceedings of the 19th Annual Conference of the Production and Operations Management Society,2008.

Lapide, L., Sales and operations planning part I: the process. *The Journal of business forecasting, 23*(3), 17-19,2004.

Lapide, L. (2005a). *Practical Guide to Business Forecasting*.

Lapide, L., Sales and operations planning Part III: a diagnostic model. *The Journal of business forecasting, 24*(1), 13-16, 2005 b.

Lee, H. L., Padmanabhan, V., & Whang, S., The bullwhip effect in supply chains. *Sloan Management Review, 38*, 93-102., 1997

Lee, H. L., So, K. C., & Tang, C. S., The value of information sharing in a two-level supply chain. *Management Science, 46*(5), 626-643, 2000.

Lee, H. L., & Whang, S., Information sharing in a supply chain. *International Journal of Manufacturing Technology and Management, 1*(1), 79-93, 2000.

Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong, Y., . . . Wong, J. Y. (2020). Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. *New England journal of medicine*.

Lockström, M., & Lei, L. , Antecedents to supplier integration in China: A partial least squares analysis. *International Journal of Production Economics, 141*(1), 295-306, 2013.

Lockström, M., Schadel, J., Harrison, N., Moser, R., & Malhotra, M., Antecedents to Supplier Integration in the Automotive Industry: A Multiple-Case Study of Foreign Subsidiaries in China. *Journal of Operations Management, 28*(3), 240-256, 2010.

Lockström, M., Schadel, J., Harrison, N., Moser, R., & Malhotra, M. K., Antecedents to supplier integration in the automotive industry: a multiple-case study of foreign subsidiaries in China. *Journal of Operations Management, 28*(3), 240-256, 2010.

Lohmöller, J.-B., *Latent Variable Path Modeling with Partial Least Squares*. Berlin: Physica-Verlag Heidelberg,1989.

Marshall, D. A., Assessing the value of supply chain information sharing in the new millennium. *International Journal of Supply Chain Management, 4*(4), 10-21,2015.

Massey, J. T., Barker, P. R., & Hsuing, S., An investigation of response in a telephone survey. In *Proceedings of the American Statistical Association* (pp. 426-431), 1981.

Matsuo, H., Implications of the Tohoku earthquake for Toyota′ s coordination mechanism: Supply chain disruption of automotive semiconductors. *International Journal of Production Economics, 161*, 217-227, 2015.

McCormack, K., & Lockamy, A., *The impact of horizontal mechanisms within sales and operations planning processes on supply chain integration and performance: a statistical study.* Paper presented at the 4th Global Conference on Business & Economics, Oxford, UK, 2005.

Mentzer, J. T., & Flint, D. J., Validity in logistics research. *Journal of Business Logistics, 18*(1), 199-216, 1997.

Mokhtar, A. R. M., Genovese, A., Brint, A., & Kumar, N. (2019). Supply chain leadership: A systematic literature review and a research agenda. *International Journal of Production Economics, 216*, 255-273. doi:https://doi.org/10.1016/j.ijpe.2019.04.001

Nabil, L., El Barkany, A., & El Khalfi, A., Sales and operations planning (S&OP) concepts and models under constraints: Literature review. *International Journal of Engineering Research in Africa, 34*, 171-188, 2018.

Nakano, M., Collaborative forecasting and planning in supply chains: The impact on performance in Japanese manufacturers. *International Journal of Physical Distribution, 2009*
Logistics Management.

Nickel, T., & Schliebener, J. (2021). Assessing supply chain resilience within the automotive industry in the event of a pandemic: A multiple case study of the COVID-19 disruption in, 2011 the Scandinavian and German automotive industry. In.

Northouse, P. G., *Leadership: Theory and Practice*. Thousand Oaks, CA: Sage Publications, 1997.

Nunally, J. C. (1978). *Psychometric Theory* (2 ed.). New York: McGraw-Hill.

Oliva, R., & Watson, N. , Cross‐functional alignment in supply chain planning: A case study of sales and operations planning. *Journal of Operations Management, 29*(5), 434-448, 2011.

Piechule, J., Implementing a sales and operations planning process at Sartomer company: a grass-roots approach. *The Journal of business forecasting, 27*(3), 13, 2008.

Ray, G., Muhanna, W. A., & Barney, J., Information technology and the performance of customer service process: A resource-based analysis. *MIS Quarterly, 29*(4), 625-652, 2001.

Remuzzi, A., & Remuzzi, G. J. T. l., COVID-19 and Italy: what next? *, 395*(10231), 1225-1228, 2020.

Saleheen, F., & Habib, M. M., Global Supply Chain Disruption Management Post Covid 19. *American Journal of Industrial Business Management, 12*(3), 376-389, 2022.

Sanders, N. R., & Premus, R., IT applications in supply chain organizations: a link between competitive priorities and organizational benefits. *Journal of Business Logistics, 23*(1), 65-83, 2002.

Sarstedt, M., Ringle, C. M., & Hair, J. F. J. H. o. m. r., Partial least squares structural equation modeling. *26*(1), 1-40, 2017.

Sawik, T. (2020). *Supply chain disruption management*: Springer.

Selldin, E., & Olhager, J. (2007). Linking products with supply chains: testing Fisher's model. *Supply Chain Management: An International Journal*,2007.

Sheldon, D. H. (2006). *World class sales & operations planning: a guide to successful implementation and robust execution*: J. Ross Publishing, 2006.

Shih, W., Is it time to rethink globalized supply chains? *MIT Sloan Management Review, 61*(4), 1-3,2020.

Singh, M. K. , What makes a winning S&OP program. *Supply Chain Management Review, 14*(3), 2010.

Thomé, A. M. T., Scavarda, L. F., Fernandez, N. S., & Scavarda, A. J. , Sales and operations planning: A research synthesis. *International Journal of Production Economics, 138*(1), 1-13, 2012.

van Hoek, R. J. L. , Exploring Progress with Supply Chain Risk Management during the First Year of the COVID-19 Pandemic. *5*(4), 70, 2021.

Vereecke, A., Vanderheyden, K., Baecke, P., & Van Steendam, T. , Mind the gap–Assessing maturity of demand planning, a cornerstone of S&OP. *International Journal of Operations & Production Management, 38*(8), 1618-1639, 2018.

Wallace, T., & Stahl, B., The demand planning process in executive S&OP. *The Journal of business forecasting, 27*(3), 19, 2008.

Wallace, T. F. , *Sales and operations planning: the how-to handbook*: TF Wallace & Co, 2004.

Whisenant, C., The politics of forecasting in sales and operations planning. *The Journal of business forecasting, 25*(2), 17, 2006.

Wold, H., Path models with latent variables: The NIPALS approach. In Blalock H.M., A. Aganbegian, F. M. Borodkin, R. Boudon, & V. Capecchi (Eds.), *Quantitative sociology: International perspectives on mathematical and statistical modeling* (pp. 307-357), 1975. New York: Academic.

Wold, H. (1980). Model Construction and Evaluation When Theoretical Knowledge is Scarce: Theory and Application of PLS. In J. Kmenta & J. B. Ramsey (Eds.), *Evaluation of Econometric Models*. New York: Academic Press.

Wold, H., Partial least squares. In S. Kotz & N. L. Johnson (Eds.), *Encyclopedia of Statistical Sciences* (Vol. 6, pp. 581-591), 1985. New York: Wiley.

WorldBank. , *Global Economic Prospects, June 2019: Heightened Tensions, Subdued Investment*: The World Bank, 2019.

Xu, H. Y., Turnover Rate 2009: lowest point in five years. *Beijing News,* p. D01, 2010.

Yang, J., Chen, X., Deng, X., Chen, Z., Gong, H., Yan, H., . . . Ajelli, M. , Disease burden and clinical severity of the first pandemic wave of COVID-19 in Wuhan, China. *Nature communications, 11*(1), 1-10, 2020.