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Abstract. Market conditions and supply chains have been under constant changes. Uncertainty has increased, and visibility has decreased, putting companies in a fluctuating environment where they struggle to survive. Several planning methodologies have been created in an attempt to prepare supply chains for the long-term. This paper denotes the most significant changes in the evolution of supply chains and explores some supply chain capability planning methodologies, proposes characteristics that should exist in today's supply chains to optimally perform and contrasts them with the approaches, identifying the gaps between them.

Keywords: Supply chain, supply chain capability planning, supply chain evolution, supply chain trends

1. Introduction

Customer demand has been constantly changing and forcing supply chains (SC) to evolve, trying to adapt to the conditions in their environment. Before, the focus was solely on controlling the everyday operations of organizations, nowadays, while operations are still the heart of manufacturing companies, much of the managers' attention has shifted towards better planning these operations and everything around them, seeking the prevention rather than the correction of any possible issues. To reach effectiveness in getting products into consumers' hands while still having the firm's profit in mind, several supply chain capability planning (SCCP) methodologies have been created. In this paper the term "capability" is defined as the combination of abilities and corresponding capacity. The accelerated and constant variations in market conditions have triggered numerous alterations in SCs and the way they are managed, this begs the question: are our capability planning methods enough to face the challenges of today's SCs?
This paper is divided into four parts: it starts with an assessment of the most significant changes through the history of SCs, followed by a review of five of the main SCCP methodologies, including their origins, purpose and process. The third part identifies the characteristics that current SCs should possess to operate effectively in their respective market and contrasts them with some assumptions and limitations of each SCCP approach to identify the gaps between them, finalizing with the conclusions and suggested research agenda. The purpose of this paper is then twofold: a review of the evolution of SCs and some existing SCCP methods, along with finding the gap between what SCCP methods offer and the SC requirements to really be successful in the contemporary context.

2. Supply Chain Evolution

In the 1950s and 1960s, manufacturers focused on mass production and very limited product and process flexibility [1]. The 1970s brought the first planning attempts with Material Requirements Planning (MRP) [2]. By the 1980s, companies became cost-centric and focused on operational efficiency due to increased competition, hence the creation of several improvement methods that required the breakage of the existing functional silos to achieve internal and external collaboration [1–3].
During the 1990s, the increase in manufacturing costs, shorter product life cycles, market economies' globalization, the surge of 'reverse logistics' for product recovery [4], along with the companies' desire to improve efficiency through the whole value chain were factors in the acceptance of 'Supply Chain Management' (SCM) [1, 5]. SCs were evolving from push systems to consumer-oriented pull systems [3]. Companies started outsourcing non-core activities in the 2000s, creating global and complex SCs [6] that

competed against similar entities [7]. Sustainability in the SCs also started to arise as a concern, extending the SC to include subjects such as remanufacturing, recycling and refurbishing added another layer of complexity to the existing SC design, operation and strategy [8].
In recent years, technology has been a game-changer for SCs. Mobile technology has and will continue to change consumer behavior, it has enabled customers to buy whatever they want, whenever they want, creating the need for companies to have an omnichannel presence so that they can keep, or perhaps even gain, market share [9]. The digitization of SCs brings the increased utilization of technologies such as IoT, machine learning, cloud-based services, and big data across the SC to make it more customer-driven, personalized, and responsive thanks to the information traveling in real time to all corners of the SC [10]. Data collection has increased in both collection points and detail, the use of it could change the way SCs are designed and managed, and many legacy methods will need to be reviewed and adapted [11]. Machine learning could automatically forecast for several planning horizons at a time and based on real-time data, saving time and resources and making the forecasts accessible at all times [12]. The delegation of decision-making could become a real possibility in the near future [13].
Table 1 shows some of the major changes in SCs.

Table 1. Main changes in SCs

Aspect	**Before**	**Now**	**Reason for change**
Demand	Stable, predictable	Volatile, difficult to predict	Fast changes in population and consumer expectations
Network	Stable, mostly local	Dynamic, global	Globalization and the pursuit of cost reduction have led business owners to internationalize their SCs
Complexity	Low	High	SCs went from linear to intricate global webs
Product variety	Limited	High	Increase of product customization options
Product life cycle	Long	Short	Fast technology advances. Firms try to innovate before competitors, increasing the number and frequency of new product development and release
Delivery lead time	Long	Short	Shorter customer tolerance time and increased ability to obtain substitute product
Planning focus	Forecast-driven (push)	Customer-driven (pull)	Forecasts are generally wrong due to the unpredictability
Order winners	Product oriented	Service oriented	Customer service has become an important area, with customers demanding more responsiveness, availability and reliability from their suppliers
Processes/ activities	Mostly in-house	Outsourced	Companies attempt to focus on their core competencies and outsource the rest of the activities

3. Supply Chain Capability Planning (SCCP) Methodologies

Several SCCP methods have been originated to prepare SCs for long-term performance and face future challenges. SCCP falls in between business strategy formulation and tactical mid-term SC planning [14]. The following subsections explore the major SCCP methods, summarizing their origins, definition, purpose and process.

3.1. Sales and Operations Planning (S&OP)

Origins. Created by Dick Ling in 1984 [15]. First seen in literature in 1988, in the book 'Orchestrating Success' by Ling and Walter Goddard [16].
Definition. "Process with which we bring together all the plans for the business (customers, sales, marketing, development, manufacturing, sourcing and financial) into an integrated set of plans. It is done at least once a month and is reviewed by senior management at the aggregate (product family) level" [15].
Objective. When done properly and in alignment with the business strategy, it ensures a synchronization between the strategic plan and the operational plan of a company [17].
Process and evolution. The process varies from company to company, but it must reconcile supply, demand and new product planning, and project at least 18 months into the future [17]. Grimson and Pyke [18] describe it as follows: first, the sales team meets to set an unconstrained sales demand forecast adjusted by

marketing plans; the second step is a meeting of the operations team where they discuss inventory policies, SC and operational capacity, and an initial supply plan is created based on the demand forecast; the next step is the formal meeting of the S&OP team to agree on the final operations plan for the next planning period; next is the distribution and implementation of the plan; and the final step is the measurement of results and effectiveness of the process. A cross-functional team should be in charge of the process, involving empowered managers from the demand side and from the supply side, as well as finance personnel to allow for an integrated view of the business [17, 18].
Due to increasing uncertainty, firms began focusing on the assumptions behind the numbers; some industries under extreme variability run alternative scenarios based on different sets of assumptions [17].

3.2. Adaptive Sales and Operations Planning

Origins. Developed in 2016 as a strategic complement for Demand Driven Material Requirements Planning (DDMRP) by the Demand Driven Institute and the creator of the original S&OP process, Dick Ling [15].
Definition. "The integrated business process that provides management the ability to strategically define, direct and manage relevant information in the strategic relevant range and across the enterprise. Market driven innovation is combined with operations strategy, go-to market strategy and financial strategy to create strategic information and requirements for tactical reconciliation and strategic projection to effectively create and drive adaptation" [15].
Objective. Created for businesses under high variability and low visibility. It keeps coherence between subsystem behavior and overall system strategy, translates strategy into operational capability, engages all areas of the organization with cross-functional communication of relevant information, ensures the continuous completeness and attainability of the business plan, and it deals with change and adapts [15].
Process and evolution. The process, according to Ptak and Ling [15], consists of seven elements:

- Portfolio and new activities. Deals with the firm's product offer aggregated into marketing families. Product lifecycle should be an input to make decisions.
- Demand. Includes a future unconstrained demand plan (forecast) at the product family level over the strategic range. Assumptions that explain the reason for any estimation should be documented. Different ranges and scenarios (expected, pessimistic and optimistic are recommended) are sought, reconciled and compared to the capability of the current operational model.
- Supply. Determines the feasibility of internal and external supply capability based on the unconstrained demand and new activity plan. The output is an attainable supply plan in volume, timing and cost, identifying capacity requirements and capability changes. Capacity management should be focused on internal or external critical resources that could be a constraint on supply.
- Financial. Fixed costs are planned in the strategic range. Some of the considerations for this element are the business plan, the availability of working capital, cash generation rates, financial restrictions, expectations of the shareholders and the financial impact of all changes.
- Integrated strategic reconciliation. It forces a collaborative cross-functional way of operating. Some of the topics to reconcile are new directives from senior management, new market opportunities, deviations from business plan, supply issues, among others. There should be an empowered team to perform this monthly process, it should focus on what is changing and perform scenario planning, clearly defining each scenario and documenting all assumptions. The agenda for the senior management business review and the information it contains is shaped.
- Demand Driven S&OP (DDS&OP). Tactical level process, its output is the configuration of the operating model and the company's capability.
- Management business review. Monthly process where senior executives manage the business forwardly, with an integrated set of plans, in volumes and financials, used by all the functions within the firm. The planning horizon is at least 18 months. During this step, risks and opportunities are analyzed, action plans agreed, and decisions taken to guarantee the strategy's successful implementation.

3.3. Collaborative Planning, Forecasting and Replenishment (CPFR)

Origins. Evolution of Collaborative Forecasting and Replenishment (CFAR), created between 1993 and 1996 amid the retail environment, when Wal-Mart and Warner-Lambert implemented it by exchanging relevant information on a certain product line, resulting in increased sales and reduced inventories [19]. Burnette [20] claims that the concept was renamed as CPFR to put emphasis on planning production and

purchasing activities collaboratively. The guidelines for CPFR were developed and published in 1998 by the Voluntary Interindustry Commerce Standards (VICS) committee [19].
Definition. "A business practice that combines the intelligence of multiple trading partners in the planning and fulfillment of customer demand. CPFR links sales and marketing best practices, such as category management, to SC and execution processes to increase availability while reducing inventory, transportation and logistics costs" [21].
Objective. "Change the relationship paradigm between trading partners and create significantly more accurate information that can drive the value chain to greater sales and profits" [22].
Process and evolution. CPFR has had two important iterations [22]. CPFR 2.0 was released by GS1 US in 2014 to face current market dynamics and aid manage a seamless omnichannel consumer experience [22], it is cyclic and consists of ten steps grouped in three main processes: (1) collaborative arrangement, (2) performance assessments, (3) joint business plans, and (4) integrated business plan in collaborative planning; (5) collaborative demand plan, (6) consensus forecast, and (7) collaborative production in collaborative forecasting; and finally (8) collaborative orders, (9) collaborative execution, and (10) collaborative fulfillment in collaborative replenishment [22].
VICS [21] states that the CPFR cross-functional team should enlist on the 'retailer' or buyer side: merchandise planning, buyers, and replenishment personnel; and on the 'manufacturer' or seller side: demand planning, sales, and customer service/logistics representatives.

3.4. Integrated Business Planning (IBP)

Origins. Considered by Palmatier [23] as a more comprehensive process evolution of S&OP. It is argued that the name change started happening in the late 1990s because the name 'Sales and Operations Planning' no longer described what the methodology was capable of [24].
Definition. "A process led by senior management that evaluates and revises time-phased projections for demand, supply, product and portfolio changes, strategic projects, and the resulting financial plans. This is done on a monthly basis, typically over a 24-month rolling planning horizon" [25].
Objective. Realignment of tactical plans for all functions of the business to support the firm's goals [25]. Besides balancing demand and supply, IBP monitors the company's performance to the strategic plan [26]. IBP does not realign short-term deviations, it aligns all business functions towards the direction that the company is set to go [24].
Process and evolution. The IBP process is said to be simple and common sense [26], the steps are:

- Product review. Validation of product plans for introduction and/or phase-out over the planning horizon; the result is the updated product portfolio.
- Demand review. Total forecasted demand opportunities supported with action plans by marketing and sales, turned after into formal product requests. There is a financial appraisal during this step to comprehend the impact and implications of the volume plan in the revenue and margin estimations.
- Supply review. Operations determines how resources will be committed to deliver the requested products. A financial appraisal helps understand cost implications and impacts of production plans.
- Financial review. The latest financial projections are reviewed and impacts on financial and investment strategies are determined.
- Integrated reconciliation. Resolution of opportunities and issues arisen during the process. If something is not solved at the lowest practical level, it is deferred to senior management.
- Management business review. The senior management team reviews the plans, issues or opportunities and gaps against the business and strategic plan, makes decisions and offers direction, and agrees on a balanced and integrated operations and financial plan.

A key aspect in IBP is the participation of finance throughout the entire process, the financial implications of all plans must be understood at all times [24].
There is another definition for IBP out there. For Smith et al. [27], IBP is the combination of S&OP, which focuses on the strategic management of internal collaboration processes, and CPFR, which is a strategic management process that aims externally towards the collaboration among supply chain partners.

3.5. Advanced Planning System (APS)

Origins. Per Kilger [28], one of the first APS to be implemented was Optimized Production Technology (OPT), based on TOC, at the end of the 1980s.

Definition. "Techniques that deal with analysis and planning of logistics and manufacturing during short, intermediate, and long-term periods. APS describes any computer program that uses advanced mathematical algorithms or logic to perform optimization or simulation on finite capacity scheduling, sourcing, capital planning, resource planning, forecasting, demand management and others" [29].
Objective. APS serve as a framework for planning optimization, not replacing ERP systems but complementing them [30], filling the gaps and compensating for the flaws in the planning area [31]. APS could improve cost, quality and time, along with increasing process transparency, improving flexibility and revealing the system's constraints [32].
Process and evolution. APS possess alternative-generating algorithms that create 'feasible' solutions, the one with the highest-quality will be chosen by an alternative-selecting algorithm; a model is then solved for each alternative and analyzed by the decision-maker, who will choose one and implement it [33]. Nevertheless, this might not be a good way to deal with stochastic features and risks, since the best choices in a stochastic environment will rarely coincide with the ones found in a certain scenario [33].
APS cover procurement, production, distribution and sales [34]. The typical software modules in APS, according to Meyr et al. [35], are: strategic network planning, demand planning, demand fulfilment and ATP, master planning, production planning and scheduling, and transport planning.
The modules for long-term strategic decisions and the mid-term tactical ones are further explained below:

- Strategic network planning. The planning range could be three to ten years and the decisions taken at this stage have long-term repercussions in the profitability and competitiveness of an organization [31, 33].
- Demand planning. Mid-term, aggregate level task. It involves predicting future sales based on all relevant information available in the SC. Decisions should be based on accepted customer orders and planned sales or forecasts. To go from demand forecasting to demand planning, any unusual situation that could influence demand in the future and its potential impact on sales need to be added to the formal demand forecasts. APS include simulation/what-if analysis tools that are useful with constantly changing demand conditions. The main output is the aggregate demand forecast [31, 36].
- Master planning. Seeks the most efficient way to satisfy demand forecasts over a mid-term planning horizon. Optimization is performed over aggregated products and materials groups and there must be a focus on bottleneck resources. The main goal is the effective synchronization of material flows along the SC. Besides balancing demand forecasts with available capacity, master planning assigns demands to sites evading bottlenecks. Thanks to the medium-term planning interval, available capacity could be adjusted to a certain extent. The most important results from the module are planned capacities for production and transportation, and the amount of seasonal stock at the end of each time bucket [31, 37].

Although APS have the functionality to integrate suppliers and customers, most implementations are limited to a single company [38]. SC optimization requires centralized planning, if members of the SC are reluctant to share data through a centralized database, SC-wide modelling would not be possible [31].

4. SCs' Current Challenges and SCCP Methodologies' Limitations

As seen in previous sections, SC's characteristics and market conditions have shifted over time. Several SCCP methodologies have surged to make SCs effective and efficient. However, most of these methods were created under relatively stable environments and, as explained in the following subsections, have become outdated and somewhat irrelevant.
The subsections below expand on the characteristics SCs need to hold to optimally perform in their corresponding markets. They are later contrasted against the limitations of SCCP methods to further explain if the planning approaches cover all aspects SCs' require to properly function in the present context. By identifying the gaps, conclusions can be drawn on what future developments should be aiming towards.

4.1. What do SCs Need to Work Properly in Today's World?

Thanks to the literature reviewed in this paper, we could identify seventeen characteristics that SCs need to possess to perform effectively under the current market conditions, these characteristics are grouped under eight main dimensions:

- ***Structure.*** Refers to supply and demand network, production/distribution capacities and product portfolio.

- SCs should have the **flexibility** that permits them to make rapid changes when needed. One common situation nowadays is partners going out of business because of their inability to keep up with the fast pace of variability, making companies rush to modify their supply network on a regular basis.
- The constant and sudden changes in demand and supply have created the need for SCs to be **open and hyperconnected** to respond quickly and effectively to the variations, ditching the closed, pre-determined structure that does not allow for any modifications. By being hyperconnected, SCs are open to opportunities and are more likely to adequately respond to changes that may impact their structure.

- ***Risk management.*** SCs are more exposed to uncertainty and variability than ever, whilst visibility continues to decrease. Businesses should be aware of potential risks and their impact.
  - SCs are vulnerable to the countless sources of uncertainty, companies have been trying to plan ways to mitigate the risks they can identify, attempting to make their SC **robust** enough to withstand the potential impact of risks.
  - The usual attitude towards risk in SCs is reactive, responding once the risk has manifested and already impacted them. This needs to shift to a more **proactive** risk management, so that risks can be identified and mitigated before there is a chance for them to significantly impact the SC.
  - SCs today are somehow stable, but not in a good way. The stability means that companies are used to a pre-established way to operate making it very difficult to implement modifications. Embracing the fact that stability is rare nowadays and adopting a positive outlook towards change might help create a more **resilient** SC that can quickly get back on its feet after the impact of internal or external changes.
- ***Communication.*** As SCs have globalized in a relatively brief time, communication between SC entities became essential for the operation of the network.
  - Communication between SC partners (external) is usually restricted and some companies keep knowledge exclusively for their use. To take advantage of all useful information, external communication not only needs to be open, but it needs to be **collaborative** in a way so that the entire SC could benefit. The weakest link determines the strength of the SC, all partners should work together to take each other to the highest level of performance.
  - Silo-ed communication within companies should be a thing of the past. Communication between the functions of a company (internal) must be fluid, cooperative and **integrated**. This would aid decision-making processes by leveraging all the views from different functions and making the most informed decision that would benefit the company, not just a specific function.
  - Trust issues are common between both functions within a company and partners within a SC. Withholding information and being secretive may result in misinformation and costly mistakes throughout the SC. Information should be **visible and transparent** for all partners.
- ***Responsiveness.*** Speed at which SCs respond to demand changes. Closely related to communication.
  - SCs need a **quick** response when facing customer demand changes. To respond appropriately, the SC should be as **informed** as possible to avoid mistakes.
- ***Planning focus.*** Refers to the main aspects that managers have in mind when planning.
  - Most companies are cost-centric and have been looking to lower costs across their SC, searching for low-cost alternatives to reduce expenses and maximize profit. What some of these companies do not realize is that some cost-reduction actions could disrupt the flow of materials and products. Firms need to be aware that **flow** is of utmost priority, without flow there would be no profit, or no company for that matter. When planning, flow should be the first and most important element.
  - Providing a product to the customer used to be enough to satisfy their expectations. Nowadays, the product by itself is not sufficient to fulfill customer's requirements, **services** that could be offered with the physical goods have become equally or more important than the product. Following this 'servitization' trend, some manufacturers have even shifted from selling the product to selling the utility that the product provides instead. Therefore, the planning process now has to consider both the product and the services that will go with it.
- ***Decision-making driver.*** This dimension deals with the elements on which decisions are based.
  - The unpredictability of market conditions has deemed forecasts to practically useless numbers since it is extremely difficult to accurately estimate the market's behavior. **Demand data** and actual orders should replace forecasts so that uncertain information is reduced.
  - Planning processes rely heavily on historical data. Technology advances facilitate the collection and distribution of **real-time data** through the entire SC with no delays, every partner has the same data as it is generated or collected, and decisions can be made based on it.
  - Manager's attention has typically been directed to the supply side of the chain, part of this could be due to the control they can have over it. However, this focus has been changing towards the **demand** direction with the objective of trying to generate and shape demand to a company's convenience.

- Operations used to be driven by a single scenario with one set of numbers (sales forecast, available capacity and inventories). To cope with uncertainty in a better way, the identification and evaluation of **multiple scenarios** is highly recommended, this helps make optimal decisions after the thorough analysis of several what-if alternatives.

- ***Production process.*** It encompasses the production scheme under which companies operate.
  - Mass production and limited product variability used to be the rule for manufacturing companies. Currently, customer demands could be highly specific, mostly in the B2C landscape, making **mass customization** necessary to respond to the particular requirements of customers.
- ***Performance evaluation.*** This dimension refers to the way performance is measured and improved.
  - Typical performance indicators that aim only to a specific function do not provide valuable information for the SC as a whole. Indicators should be **SC based** for them to reflect the true state of the entire SC and permit the continuous improvement of the collective entity.

4.2. Contrast between SC Challenges and SCCP Approaches' Assumptions and Limitations

Most of the current SCM methodologies were created during a long period of stability, which no longer holds in the present global business environment [39].
Considering the dimensions and characteristics stated in section 4.1, a comparison of SCCP methodologies is observed in Table 2. Based on the evaluated literature, we can deduct some assumptions and limitations of the methodologies seen in this paper. A more thorough explanation of where these methods are regarding each characteristic is presented in the next paragraphs.

Table 2. Where do existing SCCP methodologies stand regarding the required characteristics of current SCs?

Dimension	Characteristic (Traditional vs Required)		Supply Chain Capability Planning Methodology				
			S&OP	Adaptive S&OP	CPFR	IBP	APS
Structure	*Rigid*	*Flexible*	Rigid	Flexible	Rigid	Rigid	Rigid
	Closed	*Open*	Closed	Closed	Closed	Closed	Closed
Risk Management	*Vulnerable*	*Robust*	Vulnerable	Robust	Robust	Vulnerable	Vulnerable
	Reactive	*Proactive*	Reactive	Proactive	Proactive	Reactive	Reactive
	Stable	*Resilient*	Stable	Resilient	Resilient	Stable	Stable
Communication	*Restricted*	*Collaborative*	Restricted	Restricted	Collaborative	Restricted	Restricted
	Silo-ed	*Integrated*	Integrated	Integrated	Integrated	Integrated	Integrated
	Secretive	*Visible*	Secretive	Visible	Visible	Secretive	Visible
Responsiveness	*Slow*	*Quick*	Slow	Quick	Quick	Slow	Slow
Planning Focus	*Cost*	*Flow*	Cost	Flow	Flow	Cost	Cost
	Product	*Service*	Product	Product	Product	Product	Product
Decision-making Driver	*Forecast*	*Demand data*	Forecast	Demand data	Demand data	Forecast	Forecast
	Historical data	*Real-time data*	Historical	Real-time	Real-time	Historical	Real-time
	Supply	*Demand*	Supply	Demand	Demand	Supply	Supply
	Single scenario	*Multiple scenarios*	Multiple	Multiple	Single	Multiple	Multiple
Production Process	*Mass production*	*Mass customization*	Mass production	Mass customization	Mass customization	Mass production	Mass production
Performance Evaluation	*Function, company based*	*SC based*	Function	SC	SC	Function	Function

S&OP. The methodology requires a rigid and closed structure, it does not allow for much flexibility regarding the supply and demand network; capacities are known and rigid, and so is the product portfolio. There is not a lot of attention towards risk management, leaving the SC vulnerable, forcing it to react to disruption once it is already present, and its ability to continue functioning might be compromised. S&OP allows for cross-functional cooperation within the company, however, external communication does not appear to be present in the methodology, consequently, information stays inside the company.
Since the method was created when the market was relatively stable, it has been slow to catch up on current trends and organizations that use it might have slow response to changes. The approach is purely based on cost and focuses mainly on the physical product offer of the companies. The main decision driver of the process is the sales forecast based on historical data, and the primary focus is the supply side. In businesses under high market uncertainty, alternative scenarios are evaluated before making a final decision. Planning

with S&OP focuses on product families, not making a significant remark on high customization. According to some of the literature on S&OP, there is a lack of proper performance indicators, the evaluation of performance is based on indicators per function.

Adaptive S&OP. Being one of the most recent methodologies, its creators have a better understanding of the current market conditions and it is equipped to satisfy many of the needs of today's SCs. Since this approach has a strong focus on critical resources that could constrain the flow, capacity could be flexed to make the best use of it. However, the supply network is still considered somewhat closed.

This methodology employs risk management in some of its elements, such as the portfolio and new activities and the capacity evaluation, this increases robustness and takes on a more proactive approach towards risks, thus increasing the resiliency of the company.

The literature on this approach does not emphasize on external communication with SC partners, but cross-functional cooperation is needed to perform the process; relevant information is visible to all participants.

This method allows for quick response to changes because it is market-driven, having enough information to rapidly adapt to the market needs. It focuses on the flow of relevant information and materials rather than cost like most other methods. Planning priority is mainly towards product offer. Instead of relying completely on forecasts, Adaptive S&OP uses demand data and actual customer orders as the core of decision-making, its market-drive allows for near real-time data to be prioritized over historical data, and the attention is focused majorly on the demand side. Multiple scenarios are evaluated in the process, the recommendation is the use of pessimistic, realistic and optimistic scenarios. Having the market in mind, the approach enables mass customization driven by real demand. The set of performance indicators provide a view of the entire business rather than isolated specific functions.

CPFR. To implement it, the network and capacities need to be set and known, long-term relationships between partners need to be established, which encompasses a rigid and closed structure with low flexibility. There is no mention of risk management in this methodology, leaving the SC potentially vulnerable to risks, however, since partnerships are required to be strong and durable, the probability of risks in the supply side might be lowered, and the availability of data promises to have enough information in the demand side to have some degree of robustness in the SC. The visibility of data and information may enable the SC to be somewhat proactive and resilient in the face of disruption.

CPFR was devised as a collaborative approach, both externally and internally, point-of-sale data is visible to whoever needs it. Thanks to this data readiness, the SC can respond quickly to sudden changes in demand. This method focuses on the flow of strategic products with the goal of making them available when the customer requires. With the final consumer in the core of CPFR, decisions are taken based on near real-time demand data from the point-of-sale. There is not enough information to conclude on the use of multiple scenarios to make decisions. By knowing exactly what the consumer wants, this method might favor mass customization. The involvement of trading partners should be evaluated with SC based indicators.

IBP. This methodology operates in a similar way as S&OP, the main differentiator is the involvement of finance personnel throughout the entire IBP process and the longer minimum planning horizon (24+ months). The same assumptions and limitations as S&OP apply for IBP. The structure is rigid and closed. There is not a significant focus on risk management. It is an intra-company process involving cross-functional cooperation but there is not enough information on external collaboration in the process to reach an accurate conclusion on the aspect. The longer planning horizon might be helpful in terms of responsiveness, preparing the company to quickly answer to foreseen changes. Planning focuses in the product and it is cost-centric. Historical data is used to forecast future sales and the attention is towards the supply side. Multiple scenarios are analyzed to make optimal decisions. As stated before, there is not enough academic research on the topic and conclusions might not be as accurate as desired.

APS. The network, capacities, preferred inventories, and the cost of all these elements must be known and somewhat stable to use APS, hence a rigid and closed structure is needed. Since the methodology deals with optimization (generally maximization of profit or minimization of cost), very little attention might be paid to risk management, creating a vulnerable SC that is reactive to changes and not resilient enough when disruption happens. Despite the functionality of APS to optimize the entire SC, many companies restrict its use to internal operations. There is an integration of several functions in the process and the data is accessible for all, but each function might need different information and there is a possibility that the lack of expertise on other areas could make this visibility of data useless. SC's response may be slow, since the configuration of it is towards optimization and could be difficult to modify.

APS is completely cost-oriented (or profit-oriented, depending on the company) and it plans for the product offer of the firm. The main decision-making driver is the sales forecast, which is based on already accepted customer orders and planned sales, accompanied by any exceptional circumstances that could impact demand. The software could use near real-time data during the planning processes, thanks to its integration

with other information systems. The focus is also towards the supply side of the chain instead of understanding the demand. APS evaluate multiple scenarios until the optimal one is found.
The more variables are added to the model, the more complex it gets, more powerful systems could be needed to solve it and it might be time consuming, hence it could be better to use them in mass production where there is not a high number of distinct products. Performance indicators are function-focused.

5. Conclusions and Research Agenda

Gathering information on the methodologies is not an easy job, there are many different definitions out there for some of the methods and not enough for others. More academic research is needed for basically all of them, work that defines them and their elements in a way that truly explains their worth.
Considering the existing and potential future circumstances of the business environment, there is an obvious gap between how SCs are today and how they should be. The market conditions have evolved faster than the ways companies manage and control their supply network, SCs need to shift to keep up with the fast-rate change of their market environment.
While some of the approaches like Adaptive S&OP and CPFR are sort of aware of current market conditions and have adopted some features to deal with them, others remain forged to the old ways. If the existing SCCP methodologies fail to evolve to incorporate the recent requirements for SCs, a new method might need to surge. Many of the methodologies included in the paper are explained and divulged from a single company point of view, this could imply that they might not be optimized for the planning of entire SCs.
Generally, SCs are constituted by several businesses with different owners, thus external collaboration might become more difficult, but it is still necessary. Perhaps concepts like 'Supply Chain Control Towers' or multi-agent systems to model the business processes between companies could be of help in trying to get a wider understanding of the SC.
SC risk management practices require more attention. Companies need to act regarding the endless disruptions that could be heading towards their SC. Knowledge databases could be a suitable alternative to gather information that may be useful in the future, perhaps they could even be shared among SC partners for them to continue learning and improving.
Despite the mention of 'robustness', 'flexibility' and 'agility' in some of the evaluated work, there are no concrete ways of knowing if any of the methodologies truly increases the performance of the SC in those fields. There must be a way to measure if any approach really aids on making the SC more robust, flexible and agile, and it should be as a whole, avoiding the isolation of the entities.
'Resilience' is another topic that is currently in the spotlight. However, current methodologies do not include any feature on the subject. A methodology that enables an organization to reconfigure its network with the least possible impact in case of disruptions would help make the SC resilient, as well as providing robustness, agility and flexibility.
The use of deterministic data is predominant when planning, which is impractical nowadays when uncertainty and unpredictability reign. Alternative scenario generation may be helpful in the efforts to diminish this uncertainty but there is an infinite number of possible scenarios that are completely ignored because of the difficulty it represents to analyze them all.
Organizations also need to move away from the extensive use of historical data to predict how their future will look. Thanks to technology advances, real-time data can be collected and distributed along the entire SC, this data could be used during planning processes. However, dealing with considerable amounts of data can be complex, so algorithms or software should be developed to clean the data and leave what is useful. Big data and data mining are becoming more relevant these days, increasing research on the use of those tools in any SCCP approach may be valuable in the improvement of any method.

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