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Future Trends and Challenges in Sales and Operations Planning (S&OP): A Systematic Literature Review

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Abstract
Effective supply chain management (SCM) enhances organizational performance by optimizing resource allocation, reducing costs, and increasing customer satisfaction through streamlined operations and cross-functional collaboration. This leads to improved inventory management, higher service levels, and a competitive edge. Sales and operations planning (S&OP) plays a vital role in aligning demand forecasts with supply capabilities, fostering visibility and proactive decision-making. This minimizes inventory costs and improves responsiveness to market changes, supporting strategic goals and long-term success. Despite its importance, a gap remains in systematic literature reviews that categorize trends and challenges in S&OP. Addressing this gap aids supply chain managers in identifying and understanding current challenges and trends, facilitating informed decision-making. This study conducted a comprehensive systematic literature review, examining 295 studies and selecting 66 relevant articles published between 2012 and 2023 using screening methods coupled with TOPSIS and ANP techniques. The results reveal that most studies focus on optimization models for S&OP, employing optimization techniques, simulation, heuristic methods, artificial intelligence, machine learning, statistical approaches, and qualitative models. The research identified key S&OP planning issues and various models for addressing them. It also highlights emerging trends, such as the increasing use of machine learning and artificial intelligence to improve demand forecasting and decision support systems. Additionally, the growing focus on sustainability in supply chains, including reducing carbon emissions and minimizing waste, is being integrated into S&OP models. However, challenges persist, including dependence on accurate and reliable data, data quality issues, and organizational resistance to change. The complexity of S&OP processes also presents obstacles. This review provides insights into S&OP models, trends, and challenges, and offers future research directions, emphasizing AI integration, sustainability, and hybrid modeling approaches. Addressing these challenges can enhance alignment between sales, production, and inventory, ultimately improving business performance.

Keywords: *Sales and Operations Planning, Supply Chain Management, Machine Learning, Artificial Intelligence, Sustainability*

Introduction

The Sales and Operations Planning (S&OP) process plays a critical role in boosting organizational performance by forming a vital link between sales, production, and inventory management functions. This alignment is essential as it fosters the efficient coordination of material, financial, and informational flows, enabling businesses to effectively meet customer demand while maximizing their supply capabilities (Almeida et al., 2021). The S&OP process has evolved from a tactical tool into a strategic advantage for organizations seeking to enhance their market positions through resource-based and market-driven

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approaches to supply chain management. Research has shown that successful S&OP implementation fosters greater cooperation among business units, increases operational transparency, optimizes inventory management, improves sales and forecasting accuracy, elevates service levels, and enhances capacity utilization (Hung & Eldridge, 2019; Matsebatlela & Mpofu, 2015; Farias et al., 2017). These operational improvements not only translate into tangible financial gains but also facilitate the achievement of broader organizational visions and goals.

The historical roots of S&OP can be traced back to the early 1960s, where large corporations like General Motors and Procter & Gamble recognized the necessity for an integrated approach to sales and production, initially termed "Sales and Production Planning." During this formative era, organizations focused primarily on optimizing resource utilization and reducing operational costs (Krajewski & Ritzman, 2012). As the business environment became more complex, S&OP transitioned into a comprehensive management process, particularly refined during the 1980s by companies such as IBM and Hewlett-Packard. These firms expanded the S&OP framework beyond merely coordinating sales and production to include a variety of functions like marketing, supply chain management, and inventory controls (Farris et al., 2017).

The technological advancements of the 1990s represented a pivotal period for S&OP processes. The adoption of sophisticated information systems and management software—including Supply Chain Management (SCM) and Enterprise Resource Planning (ERP) systems—facilitated more efficient and accurate data collection and analysis (Chopra & Meindl, 2013). This technological evolution laid the foundation for contemporary S&OP practices, empowering organizations to respond more quickly to customer needs and market fluctuations.

Advancements in technology, particularly the rise of artificial intelligence (AI), have further transformed S&OP processes (Martínez-Lopez & Casillas, 2013; Jarrahi, 2018). AI applications are instrumental in optimizing processes across various sectors, including supply chain management. The multifaceted S&OP process involves crucial functions such as demand forecasting, supply planning, inventory management, and performance evaluation, all of which require significant collaboration and coordination across multiple stakeholders (Hübl & Fischer, 2017). The integration of AI and machine learning allows organizations to effectively process large volumes of data, thereby enabling more informed decision-making and operational success.

Despite these advancements, practical challenges persist in implementing S&OP models. Issues such as data quality, availability, and the integration of technology pose significant barriers to successful implementation. Additionally, resistance to change within organizations often hinders the adoption of optimized S&OP processes that necessitate substantial operational adjustments. The inherent complexity of S&OP processes requires a strategic approach that adequately captures the various factors influencing decision-making, calling for a deeper understanding of current research trends, models, and operational challenges.

The necessity of this research is evident. Optimizing S&OP processes is not solely beneficial for individual organizations; it also has broader implications for supply chain efficiency and market competitiveness. If these issues remain unaddressed, organizations risk facing persistent inefficiencies, suboptimal resource allocation, elevated operational costs, and reduced responsiveness to changing customer demands. This study aims to illuminate these challenges by developing a structured framework to assist organizations in navigating the complexities of S&OP, thus enhancing theoretical understanding as well as practical applications.

A comprehensive review of existing literature reveals a significant gap in analyses that effectively connect theoretical models with practical applications within the S&OP framework. While there has been substantial exploration concerning demand forecasting techniques and inventory optimization strategies, many studies indicate a disconnection between these theoretical constructs and their practical applicability in real-world scenarios. This research aims to bridge this gap by offering insights into how existing S&OP models can be leveraged effectively in practice. The study plans to examine current trends in S&OP optimization models and identify key variables influencing theireffectiveness.

To accomplish these objectives, the research will focus on clearly delineated goals:

Analyze Current Models: Investigate existing S&OP optimization models across various industries to assess their effectiveness and applicability.

Identify Key Features: Explore the key features, variables, and frameworks underpinning these models, evaluating both their strengths and areas for improvement.

Examine Trends and Challenges: Evaluate current trends in forecasting methodologies related to S&OP planning while identifying associated challenges that practitioners encounter.

By addressing these objectives systematically, this research seeks to improve understanding of S&OP and offer valuable insights that can bolster organizational performance through enhanced decision-making capabilities.

Moreover, the concept of professionalism within organizations, highlighted in contexts such as the Shiraz University of Medical Sciences, serves as a significant backdrop for understanding S&OP effectiveness. As a leading scientific institution in the Middle East, Shiraz University attracts a diverse student body and plays a vital role in health education and service delivery. This institution embodies principles of professionalism that include adherence to ethical standards, prioritizing societal well-being, and fostering the continuous development of knowledge and skills (Zao, 2018). Emphasizing professionalism in healthcare and education can enrich the implementation of S&OP processes by establishing a culture of collaboration, accountability, and high performance.

In conclusion, integrating effective S&OP processes is crucial for organizations striving for enhanced operational efficiency and a competitive edge. While technological advancements and innovative methodologies in S&OP present opportunities for improvement, enduring challenges like data quality issues, organizational resistance to change, and practical implementation hurdles continue to obstruct optimal performance. This research is essential for clarifying these challenges, articulating the need for optimized S&OP, and furnishing a structured framework to assist organizations in overcoming existing impediments. By emphasizing both theoretical insights and practical applications, this study aspires to make a significant contribution to enhancing organizational performance through improved decision-making and strategic alignment in S&OP practices.

Methodology

The method of conducting a systematic literature review of models, trends, and challenges in optimizing sales and operations planning (S&OP) processes follows the guidelines outlined in the Sage Organizational Research Methods Handbook (Denier and Turnfield, 2009), shown in Figure 1.

The first step in conducting a systematic literature review is to clearly define the research question and the scope of the review, as outlined in Table 1. This step establishes the focus and direction for subsequent literature searches and analyses.
In this review of S&OP optimization models and trends, the main research question is articulated as: “What are the models, trends, and challenges in optimizing sales and operations planning (S&OP) processes?”

This question focuses specifically on optimization models and trends related to S&OP processes and examines the challenges associated with their optimization. Furthermore, three sub-questions are presented:

- What models are used for S&OP planning? (RQ1)
- What features, variables, solutions, and paradigms are utilized in these models? (RQ2)
- What are the trends and challenges in forecasting S&OP planning? (RQ3).

To facilitate the search process, the scope of the review must be clearly defined. Studies published between 2012 and 2023 will be included, providing a reasonable timeframe for capturing current research and advancements in S&OP optimization models. Specifying this time range also makes the search process more manageable.

Moreover, this review encompasses a diverse range of industries, including food manufacturing, retail, healthcare, and more. Rather than concentrating solely on industry-specific issues, this approach aims to highlight generalizable optimization models and trends applicable across various supply chain contexts.

Clearly defining the research question and scope is crucial for guiding the objectives and influential parameters of the literature review. This foundational step ensures that the review is organized and systematically addresses the topic of interest. Additionally, a well-defined domain enhances the efficiency of text searching by providing specific and relevant criteria. Overall, this process lays the groundwork for creating a comprehensive systematic review of the S&OP planning literature.

As part of this initial step, a pilot search will be conducted to better understand the context under investigation and the existing literature. Utilizing the defined parameters, a targeted search will be performed in the electronic databases of various publishers to identify relevant sources for the literature review.

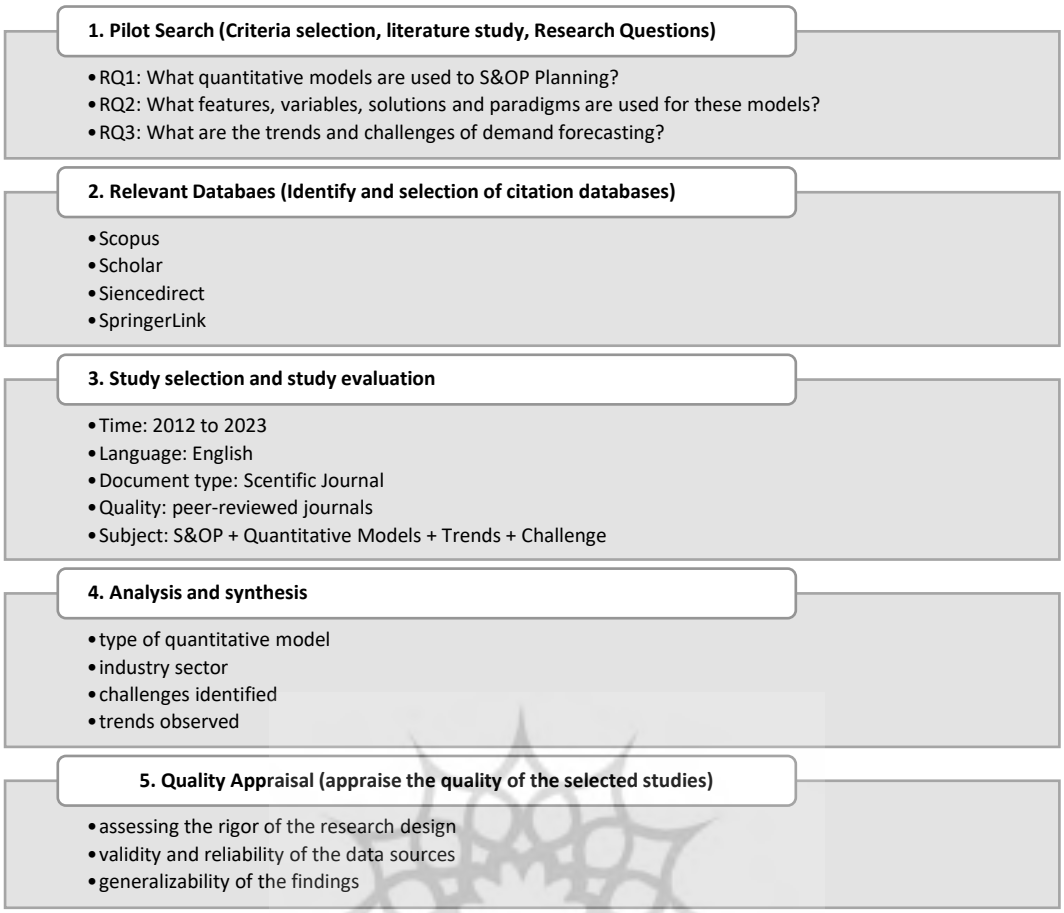

Figure 1. *Systematic literature review process*

Table 1.
Search protocol for selected literature databases

Database	Section	Field	Search string	Time
Scopus Scholar Science direct Springer Link	Title, Abstract, Keywords	Business, Management and Accounting	"S&OP" AND " Models" AND "Challenges" AND "Trends"	2012 - 2023

Table 2.
Search results based on databases and search terms.

Search string	Scholar	Science direct	Scopus	Springer Link	Total
“S&OP Planning” AND “Challenge”	2	10	18	4	34
“S&OP Planning” AND “ Model”	141	14	49	41	245
“S&OP Planning” AND “Trend”	1	7	5	3	16
Total	144	31	72	48	295

Search databases

To conduct the search, this study utilized several relevant databases, including ScienceDirect, SpringerLink, Scopus, and Google Scholar, employing expert opinion scoring to evaluate relevance. These databases were selected due to their comprehensive coverage of the literature pertaining to the subject matter. By using multiple databases, the study aims to ensure the identification of all pertinent studies, thereby minimizing the risk of overlooking significant research.

Key terms employed in this study include "sales and operations planning," "S&OP," "models," "challenges," and "trends." These search terms were carefully chosen based on the research questions and objectives, which focus on identifying and analyzing models, trends, and challenges in optimizing S&OP processes. Utilizing these specific key terms allows the study to focus the search on the most relevant literature, enhancing the validity and reliability of the findings.

The search was restricted to articles published in English. This limitation was based on the predominance of English-language publications and the peer-reviewed nature of the articles selected from these databases. By confining the search to reviewed articles, the study ensures the inclusion of high-quality research that adheres to established standards.

The search process was executed by two independent researchers to ensure comprehensiveness and impartiality. Any discrepancies between the researchers were resolved through discussion and consensus. Additionally, the authors maintained an archive of all identified studies during the search process, contributing to the transparency and reproducibility of the study.

Selection and evaluation of studies

The selection and evaluation of studies for a systematic literature review (SLR) on Sales and Operations Planning (S&OP) is a critical phase that significantly impacts the depth, quality, and reliability of the resulting analysis. By focusing on studies that specifically address S&OP processes, models, and challenges, we aim to construct a comprehensive and focused survey of this research field.

Our research began with an extensive search of relevant databases, leading to the identification of 295 articles. To ensure the integrity of our study, a rigorous screening process was implemented. This involved removing duplicate articles, applying quality ranking criteria for journals, and evaluating abstracts and full articles. As a result, we were able to narrow our selection to 66 high-quality articles that formed the core of our analysis.

However, ensuring the robustness and reliability of the selection process required the use of structured decision-making tools. For this purpose, we employed two powerful multi-criteria decision-making (MCDM) methods: ANP (Analytic Network Process) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution).

Analytic Network Process (ANP)

ANP is an advanced decision-making method that extends the traditional Analytic Hierarchy Process (AHP) by incorporating complex interdependencies between decision criteria. In contrast to AHP, which assumes that criteria are independent of one another, ANP allows for the interaction and feedback between criteria, making it particularly useful in evaluating research articles where multiple factors—such as publication quality, relevance, and author reputation—may influence each other. In our study, we used ANP to build a network model that captured these interrelationships between various criteria used to evaluate the articles. The key criteria included:

- The scientific ranking of the journal in which the article was published.
- The clarity and relevance of the article's title and abstract.
- The reputation of the authors and their expertise in the S&OP domain.

By structuring these criteria into a network, we assigned relative weights to each criterion, reflecting their importance within the overall evaluation framework. This weighting process helped ensure that all relevant factors were taken into account in a balanced manner during the article evaluation.

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)

After the ANP was used to establish a set of weighted criteria, we applied the TOPSIS method to rank the articles based on their proximity to an "ideal" solution. TOPSIS is particularly effective in decision-making

scenarios where alternatives (in this case, articles) need to be ranked based on multiple criteria.

In TOPSIS, each article was evaluated by comparing its performance against both an ideal solution (the best possible score) and a negative-ideal solution (the worst possible score). The distance from these two reference points was calculated, and articles were ranked based on their geometric closeness to the ideal solution. Articles that scored closer to the ideal were ranked higher, while those closer to the negative ideal were ranked lower. For our screening process, each article was scored on a scale of 1 to 5 using the SuperDecision software, based on the following criteria:

- Scientific ranking of the publication – Higher-ranked journals contributed to better scores.
- Quality of the title and abstract – Clarity and relevance of the content were crucial.
- Reputation of the authors – Renowned experts in the field were rated more favorably.

Articles with a score below 3 were eliminated, as they were deemed not to meet the quality standards required for inclusion in the systematic literature review.

Outcomes of the Evaluation Process

The combined application of ANP and TOPSIS allowed us to refine our selection process with precision. Initially, 295 studies were identified. After removing duplicates, 223 unique articles remained. The application of quality-ranking criteria led to the exclusion of 130 articles, and abstract evaluations removed an additional 8. A detailed review of the full texts of the remaining articles resulted in the exclusion of 20 more, leaving a final selection of 66 high-quality studies.

These 66 articles form the foundation of our literature review. By leveraging ANP and TOPSIS, we ensured that the final selection was not only comprehensive but also highly relevant and of the highest quality. This systematic approach enabled us to highlight emerging trends, best practices, and critical challenges within S&OP, providing actionable insights and a thorough understanding of the field. The use of ANP and TOPSIS in this systematic literature review was not simply a procedural step but a critical method to ensure the robustness and validity of the research findings. Through these methods, we were able to objectively evaluate and rank articles, ensuring that only the most relevant and high-quality studies were included in our analysis. This structured approach significantly enhanced the quality and focus of the review, aligning it with the primary objectives of our research.

As previously mentioned, the selection and evaluation processes are not merely procedural requirements but essential steps in ensuring the accuracy, relevance, and validity of research findings. The systematic approach adopted in screening studies plays a fundamental role in shaping the study's presentation, allowing us to deliver a detailed review based on empirical evidence and scientific discourse.

The review and screening of articles using effective criteria are crucial for analyzing studies conducted in S&OP (Sales and Operations Planning). By focusing on articles that directly address key aspects of S&OP, we highlight emerging trends, best practices, and challenges within the field. This targeted approach enables us to transform complex information into actionable insights and provide a comprehensive understanding of the research topic's dynamics.

Therefore, it can be asserted that the selection and evaluation of studies for a systematic literature review on this research topic is not only necessary for conducting the research process but also vital for validating the research findings. Through a systematic approach, we assembled a collection of research that aligns with the study's main objectives and offers valuable insights for the literature review.

Table 3 below outlines the specific process undertaken to conduct the research literature review. It details the number of articles identified at each stage of the screening process. Initially, 295 studies were identified

through database searches. After removing 72 duplicate articles, 223 unique articles remained. The researchers then applied a quality ranking review, resulting in the exclusion of 130 articles that did not meet the desired quality criteria. Examining the abstracts and frameworks of the remaining studies led to the exclusion of 8 more articles, reducing the total to 86 studies. The final step involved thoroughly reading the full texts of these studies, resulting in the exclusion of an additional 20 articles. Ultimately, a set of 66 high-quality articles remained, which form the foundation of the literature review.

The temporal distribution of the 66 scientific articles included in the systematic literature review on models, trends, and challenges in sales optimization and operations planning (S&OP) has varied over the years. These articles were published between 2012 and 2023, with a notable concentration in recent years, reflecting a growing interest and research focus in this field. The graph shows fluctuations in the number of articles published annually, peaking in 2021 and experiencing a slight decline in 2022. This trend suggests that research into S&OP optimization has significantly accelerated over the past decade.

Analysis of studies

This stage is crucial for combining and analyzing data, discovering patterns, and identifying themes related to research questions and objectives. Data extraction includes various aspects of the studies, such as model type, industrial application, identified challenges, and observed trends. These data were selected based on the objectives of the study, as well as trends and challenges within the S&OP process.

The data extraction process was conducted by two independent researchers to ensure accuracy and reliability. Any discrepancies between the researchers were resolved through discussions, and an archive of the extracted data was created to enhance the transparency and reproducibility of the studies.

Following data extraction, the analysis phase commenced to identify patterns and themes. This step required categorizing the data based on similarities and differences, and identifying recurring key themes across all studies. By employing a combination of inductive and deductive approaches, the authors gained insights aligned with the research questions and objectives of the study.

Table 3.
Search results based on execution and elimination stages

Steps	Springer Link	Science direct	Scholar	Scopus	Total
1. Search in identified Citation Databases	48	31	144	72	295
2. Remove Duplicate	41	14	120	48	223
Exclude	(7)	(17)	(24)	(24)	(72)
3. Journal Ranking Review	33	13	13	33	93
Exclude	(8)	(1)	(107)	(15)	(130)
4. Reading Abstract & Framework	30	13	12	31	86
Exclude	(3)	0	(1)	(2)	(7)
5. Reading Full Text	17	13	11	25	66
Exclude	(13)	0	(1)	(6)	(20)

Table 4.
Distribution of articles by analysis method

Analysis method	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**Total**
Qualitative Study	1	1	3	2	1	1	4	3	2	4	2	1	25
Models		3	2	3			2	1	2	2	3	1	19

Analysis method	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Optimization	1					1		1	2		1		6
Simulation			1			2	1		1		1		6
Statistical	1	1	1				1				1	1	6
AI & ML								1			1	2	4
Total	3	5	7	5	1	4	8	6	7	6	9	5	66

Table 5.
Distribution of articles by category

Category	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Perspectives	2	3	4	1	1	1	6	4	2	2	4	2	32
Challenges		1		1		2	1		2		3	2	12
Best practices	1		3	2				1	2	1	1		11
Case studies		1		1		1	1	1	1	3	1	1	11
plural	**3**	**5**	**7**	**5**	**1**	**4**	**8**	**6**	**7**	**6**	**9**	**5**	**66**

The analysis process was iterative, with interpretations and conclusions continuously reviewed in light of various issues. Additionally, a sensitivity analysis was performed to validate the findings. This involved re-evaluating the data using different criteria and methods to ensure the consistency and reliability of the results.

Fundamentally, the data extraction and analysis stage plays a central role in revealing and explaining the models, trends, and challenges of the S&OP process. Through careful collection and synthesis of data from multiple studies, the researcher's uncovered insights that define the classification of S&OP process studies. The involvement of two researchers and the implementation of a sensitivity analysis bolstered the reliability and validity of the findings, while meticulous documentation of all data extraction and analysis methods increased the transparency and reproducibility of the study.

Table 4 below presents the distribution of the 66 articles included in the systematic literature review on sales and operations planning (S&OP) models, trends, and challenges, classified by their analysis methods. The table indicates that most studies (25 out of 66) employed qualitative research methods, such as case studies and interviews.

The next most common analytical approach involved the development and application of quantitative models, with 19 articles focusing on this aspect. These studies proposed and evaluated various mathematical models to optimize S&OP processes, often incorporating techniques such as optimization, simulation, and statistical analysis.

The table also highlights the growing trend of using artificial intelligence (AI) and machine learning (ML) methods in research, with four papers published in 2021 and 2023 showcasing the potential of these technologies for demand forecasting and decision support. This illustrates that AI and ML are becoming important tools for enhancing S&OP processes.

Table 5 below categorizes the 66 articles included in the systematic literature review on sales optimization and operations planning (S&OP) models, trends, and challenges. The table shows that most of the articles (32 out of 66) are focused on presenting S&OP perspectives and approaches, such as conceptual frameworks, mathematical models, and decision support systems. These studies aim to provide new insights and methodologies to strengthen S&OP processes.

The second category was studies that discussed challenges and opportunities in

implementing S&OP, with 12 articles examining issues such as data quality, organizational resistance to change, and complexity of S&OP integration. Understanding these challenges is critical for organizations looking to adopt and optimize their S&OP practices.

The table also shows that 11 articles are each categorized as best practices and case studies. Best practices articles discuss successful strategies and techniques for implementing effective S&OP, while case studies provide in-depth analyzes of how specific organizations are using S&OP to improve their supply chain performance.

Results

One of the critical aspects of the literature review on this research topic is the results obtained from the study. The distribution of results in the systematic literature review provides an overview of the types of analyses utilized in the sales and operations planning (S&OP) process. The findings from the studies, categorized by significant issues in sales planning and operations and the solutions proposed by researchers during the study period, are presented in the following tables.

Table 6.
Sales and operation planning issues

Category	Sales and operations planning issues	Quantity	Percentage
Prediction accuracy	Incorrect demand forecasts lead to mismatches in supply and demand	13	20
Customer satisfaction	Decrease in customer satisfaction due to lack of supply and demand balance management	10	15
Inventory management	High inventory or inventory costs due to poor planning	10	15
cooperation	Lack of coordination between departments leads to inefficiency	7	10
Cost management	High costs associated with inefficiencies in the S&OP process	7	10
Supply chain flexibility	Vulnerability to supply chain disruptions	7	10
Market fluctuations	Inflexibility in plans to adapt to market changes or disruptions	3	5
Performance criteria	KPIs in capturing the effectiveness of S&OP processes	3	5
Process integration	Silent processes that cause communication delays and disruptions	3	5
Acceptance of technology	Resistance to adoption of new S&OP technologies	3	5
Total		**66**	**100**

Table 7.
Methods of solving sales and operation planning problems

Category	Problem solving method	Quantity	percentage
Mathematical modeling	Advanced statistical methods, inventory optimization models, safety stock calculations, scenario analysis	14	22
Simulation	System dynamics, digital twins	5	8
exploratory models	Lean manufacturing principles, just-in-time practices (JIT), balanced scorecards, change management strategies , continuous improvement measures	11	16
Artificial intelligence and machine learning	AI (artificial intelligence), machine learning algorithms, predictive analytics, artificial intelligence, big data analytics	10	15
Statistical models	Advanced statistical methods	8	12

Category	Problem solving method	Quantity	percentage
Qualitative and structural models	Collaborative forecasting, cross-functional teams, customer relationship management (CRM) ,advanced service level agreements SLA ,ERP systems , collaborative platforms, cost optimization tools, supplier base diversification, integrated business planning IBP ,Internet of Things (IoT) Index Key performance indicators KPIs ,(risk management frameworks , stakeholder engagement initiatives, process mapping, supply chain risk management	18	27
Total		**66**	**100**

As shown in Table 6, the main issues in sales and operations planning identified from the selected studies include forecasting accuracy, process coordination, inventory management, customer satisfaction, and process integration. These have emerged as the most critical concerns in recent years. Several important challenges have been highlighted: incorrect demand forecasts that lead to mismatches between supply and demand, decreased customer satisfaction due to inadequate management of supply-demand balance, high inventory costs or stock shortages resulting from poor planning, elevated costs associated with inefficiencies in the S&OP process, and a lack of coordination between departments leading to further inefficiencies and increased vulnerability to supply chain disruptions.

On the other hand, researchers have proposed various methods to address these problems. The most prominent solutions include collaborative forecasting, advanced statistical methods, cross-functional teams, comprehensive organizational planning systems, and machine learning, among others. These solutions, along with their respective categories, are detailed in Table 7.

Discussion

To address the main research question, we have formulated three specific research questions aimed at providing an accurate and comprehensive answer. This section addresses each of these questions in detail:

What are the models, trends, and challenges in optimizing Sales and Operations Planning (S&OP) processes?

This question focuses on the optimization models and current trends related to S&OP processes. It also examines the challenges associated with optimizing S&OP. In addition, there are three sub-questions:

- What models are used for S&OP planning? (RQ1)
- What features, variables, solutions, and paradigms are used in these models? (RQ2)
- What are the trends and challenges in forecasting S&OP planning? (RQ3)

We will delve into these questions in the next section.

Importance of Models in S&OP Planning

Models provide a systematic and structured approach to S&OP planning and enable organizations to make informed decisions based on data and analytics. They are widely used in S&OP planning to:

Optimize production and inventory levels.

Model uncertain and imprecise information.

Evaluate the impact of demand forecasting errors.

Optimize conflicting objectives.

Determine optimal production and inventory policies under demand uncertainty.

In the following sections, we will answer the specific research questions and elaborate on the importance of these models in S&OP processes.

Linear programming models

Linear programming models are among the most popular for S&OP planning, as they consider various constraints such as capacity, inventory, and labor to determine the optimal production schedule. For example, Almeida et al. (2021) proposed an optimal S&OP model for integrated steel industries focusing on minimizing production costs, inventory holding costs, and back orders, while

maximizing customer satisfaction. Nemati et al. (2018) introduced a fuzzy bi-objective mixed integer linear programming (MILP) approach for integrating sales, production, distribution, and logistics planning in a fast-moving consumer goods (FMCG) supply chain, aiming to minimize total costs and maximize customer satisfaction under uncertain supply and demand conditions. Albrecht & Steinrücke (2019) developed a continuous scheduling model for production, distribution, and sales in supply chains with reduced prices. Hassanzadeh et al. (2017) proposed a mixed integer nonlinear programming model addressing the order acceptance problem in customized manufacturing systems, focusing on maximizing total expected profit while considering capacity constraints and uncertain demand. Wang et al. (2012) presented an advanced S&OP framework incorporating multiple levels of planning and optimization techniques to improve supply chain performance, demonstrated through a case study of a manufacturing company in Slovenia. Yang et al. (2020) proposed an integrated S&OP model for multiple products, optimizing the number and timing of advertising and production decisions, illustrated with a case study of a Chinese company.

While linear programming models are widely used, other models have also been applied in S&OP planning. Markov Decision Process (MDP) models handle S&OP planning decisions under uncertainty. Discrete event simulation models evaluate the performance of S&OP planning systems under different scenarios. Multi-objective optimization models aim to optimize conflicting objectives, such as balancing production costs and customer service levels. Fuzzy logic models manage uncertain and imprecise information in S&OP planning.

Recent trends in S&OP research include the increasing use of data analytics and machine learning techniques, which are revolutionizing S&OP planning. Additionally, there is a growing focus on minimizing carbon emissions in the supply chain as part of S&OP planning. Despite these advancements, several challenges remain. The lack of data integration and collaboration across organizational processes makes it difficult to manage uncertainty and fluctuating demand effectively. Uncertainty in demand can lead to either insufficient or excess inventory, resulting in lost sales or increased costs. To address these challenges, organizations should invest in data integration and enterprise process collaboration tools to enhance the efficiency and effectiveness of their S&OP processes.

Simulation models

There has been growing interest in using simulation-based optimization models to enhance S&OP processes. This section discusses some recent studies employing simulation techniques to optimize these processes. Tliba et al. (2022) proposed a dual digital dynamic scheduling method for a manufacturing plant and evaluated its effectiveness through simulation, comparing it with other scheduling methods. Al-Hafsi et al. (2018) introduced a simulation-optimization framework for S&OP in a co-production context, aiming to explore new product opportunities. This framework combined a multi-period mixed integer linear programming model with a discrete event simulation model, demonstrating its effectiveness in a case study.

Lim and Kim (2014) utilized advanced planning and scheduling systems (APS) in S&OP planning, employing simulation to test various production scenarios and analyze the results. Dravai et al. (2017) presented a simulation-based business scenario, comparing different logistics and production scenarios using S&OP planning and analyzing the learning outcomes. Zendieh et al. (2020) proposed an optimization model based on stochastic multi-objective simulation for S&OP planning in a make-to-order and outsourcing context. They applied the model to a case study of an Iranian company, comparing it to traditional S&OP models. In the automotive industry, Zhang and Wang (2017) developed a simulation

optimization approach for S&OP planning in make-to-order environments, combining demand forecasting, capacity planning, and production scheduling, and tested it through a case study.

Simulation-based optimization models offer several advantages over traditional optimization models in S&OP planning. They enable the analysis of complex systems with various sources of uncertainty such as demand and time variability. Simulation can also provide valuable insights into system dynamics, crucial for understanding the impact of different decisions on overall system performance.

Despite these benefits, challenges remain in using simulation-based optimization models for S&OP planning. The complexity of simulation models can make interpreting results and effectively communicating them to decision-makers difficult. Additionally, the accuracy of these models heavily relies on the quality of input data, which can be challenging to obtain in real-world settings.

In conclusion, literature shows that simulation-based optimization models are increasingly used to optimize S&OP processes. The studies reviewed demonstrate the effectiveness of simulation in enhancing S&OP planning across various contexts. However, there are challenges, primarily the need for comprehensive data input and the development of accurate representations of real-world supply chain dynamics.

Artificial intelligence and machine learning models

The use of artificial intelligence (AI) and machine learning (ML) techniques to optimize S&OP processes has been gaining significant attention. This section discusses several recent studies that have employed these techniques to enhance S&OP processes.

Effat et al. (2022) proposed a deep learning model using Hybrid Adaptive Trend Estimation Series (HATES) for sales modeling and forecasting. The HATES method combines the strengths of adaptive filtering and trend estimation to improve the accuracy of sales forecasting. The authors evaluated the performance of the HATES model using real sales data from a supermarket chain in Bangladesh. Hossein Nia and Ebrahimi (2022) conducted a systematic literature review of deep learning applications in supply chain management (SCM), focusing on identifying current research trends and gaps, and providing a framework for future research. This review covers various SCM areas, such as demand forecasting, inventory management, production planning, and logistics, and discusses the benefits and challenges of using deep learning in each area.

Shakeri et al (2020) explores how contracts can effectively coordinate a two-tier supply chain under competitive conditions, particularly focusing on managing the uncertainties in demand for perishable goods. Alavi et al (2020) develops a mathematical model that utilizes the Bee Algorithm for selecting production suppliers, demonstrating its effectiveness compared to traditional Genetic Algorithms in optimizing supplier selection processes within supply chains.

Kim et al. (2019) proposed a machine learning-based demand forecasting model for mass customization in smart manufacturing. The authors demonstrated the model's effectiveness through a case study of a South Korean manufacturing company. Ferreira et al. (2023) presented a case study on the redesign, intelligent, and digital activation of S&OP processes in a home appliance manufacturing company. Using a qualitative research approach, the authors analyzed the impact of the redesign on the S&OP process.

AI and ML techniques offer several advantages over traditional optimization models in S&OP planning. These techniques can handle large and complex datasets, identify patterns and trends in the data, and make accurate predictions. The use of AI and ML can improve the accuracy of demand forecasting, reduce inventory costs, and increase customer service levels.

However, despite these benefits, challenges remain in using AI and ML

techniques for S&OP planning. The accuracy of the models heavily relies on the quality of the input data, which can be challenging to obtain in real-world settings. Additionally, the complexity of these models can make the results difficult to interpret and effectively present to decision-makers.

In summary, the literature review indicates that AI and ML techniques are increasingly being used to optimize S&OP processes. While these techniques have shown promise in the discussed studies, their implementation can be problematic due to issues related to data availability and quality, as well as the expertise required to develop and maintain these complex models.

Heuristic models

The importance of heuristic models in optimizing S&OP processes has been increasingly recognized. This section discusses some of the recent studies that have utilized these models to enhance S&OP processes.

Jansen et al. (2013) propose a waiting time forecasting (LTA) method for supply chain operations planning (SCOP) that improves planning accuracy by considering waiting time variation and its impact on inventory performance and service levels. The LTA method involves estimating the delivery time distribution and adjusting the reserve stock and order quantities in the SCOP model. Wolfshornd et al. (2020) investigated the use of an advanced planning system (APS) as a support tool for sales and operations planning (S&OP) in a Brazilian automotive company, analyzing the implementation process, benefits, limitations, and the importance of organizational culture and communication for successful APS and S&OP implementation.

Oliveira et al. (2022) conducted a study to address the challenges of implementing S&OP in a medium-sized auto parts company. They identified key barriers such as lack of communication, resistance to change, and data quality issues, providing solutions to overcome these challenges. Prasad (2021) investigated the impact of smart ERP on supply chain agility and the use of graph theory for adaptation in the Indian automotive industry.

Erat & Ferreira (2015) proposed an inventory management framework (IMF) to minimize supply and demand mismatch in a manufacturing organization, examining S&OP and inventory management while considering holding costs and inventory levels. Havaldsen et al. (2015) analyzed the use of complex production planning (MPS) techniques to improve performance in manufacturing organizations through a case study.

Boyer and Verma (2014) suggested the use of Internet-based tools to enhance S&OP and supply chain integration, discussing benefits, challenges, and implementation recommendations. Galán-Ordax et al. (2018) recommended using S&OP to enhance tactical planning in food retailing, identifying challenges and providing effective implementation recommendations.

Sitorus & Womsiwor (2022) presented a case study on an explosives company's implementation of S&OP and an economic order quantity (EOQ) model to improve effectiveness, describing the process and benefits. García Arca et al. (2021) proposed a predictive S&OP approach based on statistical demand forecasting to increase supply chain efficiency, demonstrating its effectiveness through simulation and comparison with traditional S&OP approaches.

Shafiq et al. (2020) discussed the use of big data analytics to enable integrated business planning through S&OP, describing the implementation process and benefits in a manufacturing company. Moras and Nagai (2014) proposed a method for adjusting reserve stock in manufacturing systems with S&OP, using a simulation model to evaluate its effectiveness.

Machuca & Rodríguez (2013) provided an overview of the evolution of operations planning and control (OPC) from manufacturing to supply chain, analyzing main concepts, models, and tools, and

discussing future research challenges and opportunities.

In conclusion, the systematic literature review shows that heuristic models are increasingly used to optimize S&OP processes. The studies discussed demonstrate the effectiveness of these models in improving S&OP planning across various fields. The main challenge in using heuristic models is balancing simplicity with the ability to capture the nuances of the S&OP process.

Statistical models

Statistical models are still being used to optimize S&OP processes. This section discusses several studies that have utilized statistical models to enhance S&OP processes.

Das et al. (2018) examined the role of multitasking teams and social identity theory in S&OP performance. Their study was based on a survey of S&OP teams in manufacturing organizations. Garcia and C. Changko (2013) investigated the impact of S&OP on manufacturing operational performance by conducting a survey among manufacturing companies in the Philippines.

Lee et al. (2022) proposed a sustainable S&OP process involving stakeholder engagement to address sustainability issues in the supply chain. They discussed key challenges and provided recommendations for effective stakeholder engagement. Huang et al. (2022) analyzed the relationship between sales culture and S&OP, as well as supply chain performance. They examined the mediating effects of five coordination mechanisms: information sharing, decision synchronization, resource allocation, incentive alignment, and communication management, using survey data from Chinese manufacturing companies.

Sosa and Ferreira (2014) studied the impact of different S&OP methods on manufacturing operational performance, collecting data through surveys and employing structural equation modeling in Portuguese manufacturing companies. Zhang et al. (2012) proposed a decision model for a make-to-order supply chain, considering uncertainty in demand and delivery time. They developed and tested the model using stochastic programming.

In conclusion, the systematic literature review indicates that statistical models are being increasingly used to optimize S&OP processes. The studies discussed demonstrate the effectiveness of these models in improving S&OP planning across various fields. The main challenges in using statistical models for S&OP optimization include the availability and quality of historical data, as well as the ability to incorporate external factors that may affect demand.

Qualitative and structural models

Qualitative and structural models are still being used to optimize S&OP processes across a wide range of applications. These models enhance decision-making capabilities, reduce costs, increase efficiency, and improve customer satisfaction. This section discusses several qualitative and structural models that have been employed to optimize S&OP processes.

Crowther et al. (2021) provide a comprehensive review of the S&OP literature from both empirical and theoretical perspectives. This review covers various topics related to S&OP, including its definition, goals, benefits, challenges, and success factors. The authors discuss diverse models and methods used in S&OP, concluding that there is no one-size-fits-all approach, and organizations should tailor their strategies to their specific contexts.

Monksgaard et al. (2014) propose a value-based approach to supply chain innovation and identify key success factors. They conclude that organizations should focus on creating customer value while ensuring efficient and effective supply chain operations. The authors propose a framework integrating customer value, supply chain capabilities, and financial performance to guide supply chain innovation.

Holby et al. (2015) investigated the flexibility of a dairy company's supply chain

in Norway, identifying factors affecting flexibility, such as demand diversity, capacity utilization, and production complexity. They propose a model to help organizations improve flexibility by addressing these factors.

Ehsani et al (2020) presents a framework that identifies and assesses various factors influencing organizational performance within supply chains, emphasizing the need for systematic evaluation to enhance efficiency and effectiveness. Pereira (2020) reviews the literature on decision-making models and proposes a comprehensive framework for S&OP. The author argues that S&OP should be viewed as a strategic process integrating finance, marketing, and operations. The proposed framework includes four key elements: demand planning, supply planning, financial planning, and scenario planning.

Rangaswamy et al. (2019) identified emerging trends in the evolution of S&OP towards Integrated Business Planning (IBP). They state that IBP represents the next step in S&OP evolution, involving the integration of business planning processes across all organizational functions. The authors propose a model integrating demand planning, supply planning, and financial planning to guide IBP efforts.

Torabi et al (2021) develops a structured model using Interpretive Structural Modeling (ISM) to identify and analyze the key factors influencing the maturity of technology, aiming to enhance understanding and decision-making in technology management.

Gomez et al. (2020) presented a case study on designing and implementing the S&OP process in a manufacturing company. They found that key success factors include top management commitment, mutual cooperation, and effective communication.

Shafiei et al (2020) identifies key indicators that influence the adoption of management accounting innovations during economic crises, utilizing both qualitative and quantitative methods to develop a structural model that highlights the role of economic indicators, organizational culture, and technology in enhancing management practices.

Tavares Tom et al. (2012) provide a research synthesis of the S&OP literature, suggesting major themes, research trends, and gaps, and future research directions. They highlight the main research topics in S&OP, such as demand management, capacity management, and inventory management. They also identify a need for more research on the role of information technology and the impact of external factors on S&OP.

Wallace and Stahl (2014) provide a framework for aligning organizations with S&OP processes. They argue that successful S&OP requires alignment of people, processes, and systems. Their framework includes defining the S&OP process, aligning the organization, developing the S&OP plan, implementing the plan, and monitoring and improving the process.

Lee et al. (2014) propose a coordination framework for S&OP based on a systematic literature review. This framework consists of four components: organizational structure, decision-making process, information system, and performance measurement. Effective coordination between these components is critical for the success of S&OP.

Wang et al. (2018) provide a literature review of S&OP research from a context-oriented perspective, covering studies published between 2010 and 2018. They identify research gaps and future directions, emphasizing the need for more research on the role of information technology, external factors, and the effectiveness of different S&OP models in various contexts.

Other case studies include implementing S&OP in the industrial food manufacturing sector (Garcia & Sy-Changco, 2015), introducing new products (Reijnders et al., 2022), and using S&OP to improve supply chain performance in a multinational manufacturing company (Sousay et al., 2021). Methodologies for implementing sales forecasting models (González-Rodríguez et al., 2019) and managing

evolutionary paths of S&OP implementation (Brito et al., 2018) are also explored, as well as assessing the maturity level of demand planning (Wikner et al., 2018) and S&OP process performance measurement (Grzybowska-Brzezińska & Kubiak, 2016).

In general, qualitative and structural models demonstrate the effectiveness of these models in improving S&OP planning across various fields. Models help organizations optimize production and sales plans, reduce costs, and enhance efficiency and customer satisfaction. The main challenge in implementing these models lies in overcoming organizational resistance to change and fostering a culture of cooperation and continuous improvement.

Conclusion

To answer the three research questions, this article reviewed articles from the Scopus, Science Direct, Springer, and Google Scholar databases published between 2012 and 2023. Initially, 295 articles were identified. After several filtering stages, including the application of a combined ANP and TOPSIS model, 66 articles were selected and analyzed.

Through the first research question, "What models are used for S&OP planning?", it was found that S&OP planning utilizes various models including mathematical modeling, simulation, artificial intelligence and machine learning models, statistical models, heuristic models, and qualitative and structural models, all of which significantly emphasize optimization techniques.

Addressing the challenges in sales and operations planning (S&OP) necessitates a combination of innovative methods and continuous improvement strategies. The use of artificial intelligence (AI) and big data analysis plays a crucial role in enhancing the accuracy of forecasting and process efficiency. Machine learning algorithms can analyze historical sales data and influential variables such as consumer behavior, market trends, and seasonal variations, helping to identify hidden patterns and trends that improve demand forecasting. Additionally, big data analysis can identify excess or shortage inventory, thereby reducing inventory holding costs through optimization models.

Promoting departmental coordination is another key element. Effective collaboration and coordination among various organizational departments such as production, marketing, finance, and supply chain are critical success factors in S&OP. Collaborative platforms like ERP systems and collaborative software can be very useful in achieving this goal, as they facilitate real-time information sharing between departments. Furthermore, the formation of cross-functional teams comprising representatives from different parts of the organization can enhance interaction, leading to faster and more efficient decision-making.

Resource optimization models also play a significant role in improving resource management and reducing costs. Using mathematical models and simulations to predict and evaluate different scenarios helps organizations make optimal decisions in response to market changes. These models can identify weaknesses in the supply chain and offer effective solutions to improve processes.

In summary, a combination of innovative methods and continuous improvement can help organizations tackle S&OP challenges and enhance their processes.

Limitations

Despite the significant contributions to optimizing Sales and Operations Planning (S&OP) processes, this research has several limitations that may constrain its impact. Below are some of these limitations:

Diversity of Industries: Due to the wide variety of industries and the specific characteristics inherent to each, the results of this research may not be broadly applicable across all fields. The unique conditions and requirements of each industry can influence the effectiveness of the considered models.

Failure to Consider Rapid Market Changes: The study does not specifically investigate sudden changes in market

demand, competition, and economic conditions. These fluctuations can significantly impact S&OP performance and potentially affect the research outcomes.

Limited Evaluation Criteria: The analysis is restricted to certain criteria, and the reviewed results cover only a small portion of the complex aspects of S&OP. Consequently, some key factors may not have been fully considered.

Indirect Review: Many results in this research are based on literature reviews and past studies, indirectly referencing the real experiences of organizations. This approach may lead to inaccuracies in presenting results and operational recommendations.

Insufficient Attention to Organizational Culture: The importance of organizational culture and its impact on S&OP processes is not addressed. Organizational culture can significantly influence the implementation and success of best practices, and ignoring it can limit the understanding of the results.

Acknowledging these limitations can help researchers and experts adopt more comprehensive approaches in future studies on optimizing S&OP processes. Efforts to eliminate or minimize these constraints will enhance the robustness and applicability of the findings.

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