Transforming supply chains through integrated business planning supported by advanced technologies

Abstract
Integrated business planning first requires multi-disciplinary stakeholder collaboration and alignment, which can be very difficult to achieve in practice and the importance of which is often underestimated. Embracing and implementing a successful stakeholder engagement model requires intentional efforts to share information, remove long-standing silos, align on priorities and align on an execution strategy. Furthermore, planning for future demand through a shared execution strategy poses additional challenges given the complexities of projecting demand and aligning supply plans to marketing strategy and sales goals. This paper presents an overview of the common pain points experienced by supply chain professionals today, along with strategies for transforming supply chains through integrated business planning and the use of advanced technologies. By combining adequate organisational alignment with the power of advanced technologies, the full benefits of integrated business planning can be realised.

Keywords
sales and operations planning (S&OP), integrated business planning (IBP), stakeholder engagement, machine learning, automation
SUPPLY CHAIN CHALLENGES: COMMON PAIN POINTS IMPEDING INTEGRATION

Integrated business planning (IBP) was introduced by Oliver Wight as a practical solution that, if deployed correctly, has the potential to remove common pain points associated with running supply chains by integrating all plans, deploying an overall business strategy and fostering proactive business decision making. Over the last two decades, a significant body of research has emerged on the topic of improving supply chain integration, in both academic and business management circles, including a comprehensive synthesis of the topic from both intra- and inter-organisational perspectives. While, in theory, most business leaders recognise the value proposition of IBP, a truly integrated supply chain remains elusive for most firms. Since the benefits of improved integration are well understood, and the technology requirements and organisational conditions required to improve are documented in the literature, business leaders must ask: why do most supply chains remain sub-optimised?

To optimise supply chains, it is crucial to understand the underlying fundamental barriers to integration. Figure 1 depicts common supply chain pain points, their underlying dysfunctions, and the root causes of the underlying dysfunctions. Two weaknesses commonly observed in supply chains include the inability to have one single source of truth and a lack of agility to respond to changes in market conditions and consumer trends. Absence of a single source of truth generally has roots in a broader lack of alignment and the existence of functional silos, whereas the inability to manage demand and supply at scale most often stems from a dependency on manual processes and a lack of visibility into future demand, creating a reactive instead of a proactive system.

FIGURE 1  Supply chain pain points, underlying dysfunctions and root causes
Source: Authors
With this view of common pain points, it is easier to understand the complexity of change and stakeholder alignment that is required to move beyond sales and operations planning (S&OP), including the inherent legacy misalignment and silos that come with that system. Organisational and cultural barriers are often greater than the expected technology or financial barriers associated with IBP.

SUCCESSFUL SOLUTIONS: A TWO-PHASE APPROACH

Because IBP is comprised of both organisational and technical initiatives, examining and addressing both aspects in a two-phase approach enables successful advanced technology-supported solutions (see Figure 2).

ALIGN: PREPARING THE ORGANISATION FOR SUCCESS

The premise of S&OP systems is to integrate disparate processes and systems for planning. The importance of this is clear: common stakeholders outside of supply chain include marketing, sales, finance, senior leadership, suppliers, owner operators and third-party logistics, all of which are heavily reliant on accurate forecasts to ensure supply meets demand. Unfortunately, the priorities of these various stakeholders are often very different and even conflicting, creating a fundamental lack of alignment in the components of S&OP. For example, marketing may have an overly favourable view of the expected performance of their promotional calendar, which will create challenges for the supply chain function. Similarly, sales may have specific financial targets that run counter to finance’s business forecast. The result is a lack of alignment between functions that prohibits one source of truth, creates significant challenges on the operations side of the business, and undermines the overall company strategy.

Functional silos can emerge from a lack of stakeholder alignment or they can be a cause of a lack of alignment. In either case, their impact on the business is substantial in both scope and magnitude. Some consequences of silos include inaccurate demand forecasts and an inability for the functional units to meet their individual goals or targets. So, in moving to an IBP model, engaging all stakeholders who are affected by and/or who affect the supply chain process is a critical step towards transformation. The importance of a clearly defined and communicated vision cannot be understated, and the vision should include a roadmap with measurable goals.

Although assessing the extent to which functions are aligned to corporate vision and strategy is a critical driver of the transformational process and leading through change, this part...
of the process is often undervalued. Therefore, deliberate focus and greater efforts should be given to initial assessments of alignment. Various processes and tools can be utilised to address this critical aspect of preparing for IBP. For example, the Holistic Leadership Questionnaire (HLQ)\(^8\) can be used to assess and monitor the organisation’s current state and culture, with a particular focus on organisational alignment. The instrument measures four major domains or valences, which include mission, vision, collaboration and partnership. Using a structured process such as HLQ, organisational leaders can identify on disconnects and remedy them to ensure alignment to the common vision and strategy required for greater integration.

For alignment to translate to action in supply chain integration, communication of each function’s goals must be transparent and understood both within and across functions. For example, supply planning should know and understand marketing’s goals and objectives and a feedback loop should be in place for supply planning to inform marketing of any constraints that might affect marketing’s plan. For IBP to be fully supported, all functions within the company must share and align their goals with the supply chain function; all too often, this step is not viewed as a priority, which exacerbates the tendency for multiple sources of truth and establishment of conflicting priorities.

Having alignment to common goals and objectives, however, is not sufficient for achieving a collaborative and holistic culture; measurement and ties to performance are key aspects of any change management practice. In addition, education and training should be provided,\(^9\) where individuals from the varying functional silos sit together and learn about the benefits that integration can yield, as well as how each one of them can contribute to a shared integrative strategy.

**BUILD: AN INTELLIGENT SUPPLY CHAIN SUPPORTED BY ADVANCED TECHNOLOGIES**

As indicated in the previous section, stakeholder alignment is a critical part of creating a truly transformed supply chain. For a holistic plan to be properly executed and IBP to be fully realised, however, advanced technologies must be used to support the execution of the plan. Therefore, in addition to the need for an actionable stakeholder engagement model, the supply chain function requires a process that is heavily dependent on data and technology to support the operations function while executing the strategy. Gaining access to data and insights in real time (or near-real time) is often the first significant challenge. For many supply chain functions, analysing data for actionable insights requires a manual and time-consuming process that cannot scale without significant costs to the system, resulting in a very reactive system with missed opportunities and suboptimal decisioning. Therefore, to fully empower a supply chain function, IBP needs to be supported through advanced technologies. In fact, automation at scale becomes particularly important as the size of the system increases as well as the complexity of the system.

**Benefits of building an intelligent supply chain**

Scaling solutions in the cloud allows for just-in-time insights and has the potential to dramatically reduce the cost
associated with a high touch, manual process. A case study based on internal research conducted by HAVI indicates that efficiency gains of approximately 80 per cent were achievable with an automated solution. To put that into perspective, what would normally take ten people to deliver with a manual solution would take as few as two people to deliver with an automated solution supported by machine learning. As a consequence, the estimated solution delivery costs at scale would be as much as 50 per cent lower after accounting for people and technology resource allocations. With that being said, human judgment should always play a role in determining what actions should be taken and how, and costs associated with the development of an automated solution should be considered as part of the financial business case. Other advantages of creating a scaled solution include the elimination or reduction of bias in the system, a single source of truth, and increased proactivity creating system agility.

For a supply chain function to be proactive and agile, the ability to predict demand up to 18 months into the future (ample visibility into the future to cover the planning period) and simulate various scenarios is a requirement of the solution. Therefore, supply planners and analysts cannot be limited to historical views and descriptive level analytics. Predictive and prescriptive analytics, combined with advanced technologies, must be implemented for stakeholder requirements to be met and the company’s strategic initiatives to be supported. Having such capabilities in place allows for a holistic view that attempts to address the various goals of the functional units. For example, having the ability to simulate the impact of the marketing calendar on top-line revenue, profit and transactions provides a view into which promotions can increase transactions while simultaneously increasing revenue and/or profit. If the goal of finance is to increase revenue while the goal of the store owner is to increase profit and the goal of marketing is to increase transactions, the optimal promotional calendar can be simulated while simultaneously focusing on those key business metrics.

In addition to the need for predictive and prescriptive analytics in general, it is important that the forecasts are granular enough so that market-level impacts, or potentially even location-level impacts, are known. Furthermore, baseline sales versus promotional calendar impacts need to be differentiated so that the specific and unique impact of planned promotions are known. To ascertain baseline from promotional lift at a store or market level, the demand plan must also factor in external data such as local events and weather data. Being able to ingest, integrate and process large amounts of data in real or near-real time requires the use of machine learning algorithms that can scale in the cloud.

Once a validated and accepted methodology is implemented, some of the benefits of advanced analytics include the ability to simulate outcomes in near-real time through predictive analytics. For example, marketing (or other functions) can test their ideas and hypotheses by simulating promotions to determine their impact on revenue, profit and transactions. This allows for the predictive, futuristic view of demand. Decisions can be made based on these simulations instead of solely based on historical views and/or gut feelings and emotions. Furthermore, intelligent decisions can be made based on a holistic and extensive view of predicted performance, which
includes things such as halo and cannibalisation, while controlling for external factors such as weather and local events.

Simulations through machine learning algorithms can be particularly powerful when trying to predict the impact of a new product launch or a limited time offer where historical sales are limited or non-existent. Proxies can be identified through analytics to help generate a starting point, which would represent the base level of sales stripping out promotions and seasonality. Proxies can also be used to determine seasonal impacts to apply to adjust the base level up or down as needed. Once the base sales level is determined, a third phase of modelling can be conducted to determine any promotion-related effects resulting from specific tactic types (e.g., price discounts, buy one and get one free) and advertising channels and levels.

Finally, advanced analytics allows stakeholders to prescribe what to do so that they can simultaneously meet the individual functional goals while optimising results across functions. For example, recommender engines can be leveraged to provide on-demand recommendations regarding products, tactics, time frames, etc. that will result in optimal performance across category unit sales, revenue, profit and transactions.

**Process for building an intelligent supply chain**

The first step in creating an intelligent supply chain is to understand the business needs and solution requirements; ideally this process would take place when stakeholders align on a holistic plan supported by shared goals and objectives. Gathering the business requirements and translating them to technical, functional and non-functional requirements is a rigorous and necessary process, which can help to eliminate technical debt and provide necessary instructions for the development team. Without thorough specification of the business requirements, the solution will not likely meet the expectations of the business and the technical requirements will not provide sufficient directions to the development team. As a result, the development team will spin their wheels and become frustrated and disgruntled. In addition, the final solution will not be developed on time, and it will fall short on its ability to support the strategic vision.

Once the requirements for a scaled solution are identified, a critical next step is to decide what to buy versus what to build. In many cases, the best approach is a hybrid approach. For example, the cloud architecture to support the solution (e.g., Microsoft Azure or AWS) could be bought while the data processing logic, methodology and algorithm implementation may be handled through in-house processes and people. On the data side, the business requirements will determine which data sources are needed and then the business can determine what data is available in-house versus which data sources need to be purchased via third-party vendors. In addition to the business stakeholders, it is critical to have input from cloud solution architects, data engineers and data scientists to best assess what technology to adopt and how best to build it or what to buy.

If creating the solution in-house, the overall methodology for the analytics must be considered prior to prototyping and testing statistical models or algorithms. Methodology includes how to handle data issues (e.g., missing data, poor quality data, anomalies) as well as how to model the data. For example, a decision needs to be made whether to
model using a bottom’s up approach and roll up the forecasts to obtain a top-line revenue number, or to create a top-line revenue forecast and share out to the lowest level needed for restaurant order proposals. Marketing, sales and finance will have a different requirement than will the supply chain function; supply chain will likely need very accurate granule level forecasts that account for halo and cannibalisation to ensure optimal supply while other functions will likely be most interested in top-line revenue and/or incremental revenue (eg incremental revenue resulting from promotional activity). Therefore, a best practice is to create both a bottom’s up forecast and a top-line forecast, and then reconcile the two forecasts. Finally, the analytical approach may need to be interpretable versus simply accurate. In this case, statistical models (eg regression-based algorithms) may be preferable to more black box machine learning algorithms (eg support vector regression, neural networks).

Once a methodology has been identified, prototyping may begin. Prototyped models should be built and tested via the use of training and test sets, where a portion of the data is used to build (train) models and another portion of the data is held-out to validate the trained models based on out-of-sample forecasting accuracy. Many different types of algorithms can be used depending on the data available, but the overall process is the same: explore data, clean data, prep data for modelling, model data, validate models and implement at scale. A best practice is to try to keep the solution as vendor-agnostic as possible, and therefore use components of the infrastructure and code base that are common across various platforms (eg Python libraries and packages, SQL, Postgres).

In addition to the accuracy associated with the algorithm used, whether it be a traditional statistical model or a machine learning algorithm, processing time and cost should be key performance indicators in the selection of analytical approaches. Therefore, three key performance indicators are critical to the success of advanced analytics and data science implementation: model accuracy, run-time and compute cost. Makridakis et al.12 conducted a benchmark study comparing traditional statistical models to machine learning algorithms, which can be used as a starting point. With that being said, results will likely vary across different use cases, and the best approach may depend on factors outside of the scope of their article.

Figure 3 provides an overview of the process flow for building an advanced analytics solution. The first step, as indicated previously, is to gather all the solution requirements; this process may take a few iterations to ensure that the requirements are clearly communicated to, and understood by, the development team. The second step is to determine what to build versus what to buy. It is important to note that this could change throughout the development cycle. The third step is to acquire and process all the necessary data (data validation, cleaning, and integration). The fourth step is to align on a methodology and build the models, which consists of data exploration and transformation of the data to prepare the data for model ingestion (eg feature engineering). The models will be prototyped and validated in a lab or sandbox environment. It is important to make sure that the analytical and machine learning components are designed prior to beginning the build of each feature in the development environment. Also, when evaluating which models to build...
into the product, it is important to keep in mind the key performance metrics (prediction accuracy, run-time and cost). The prototyping and validation phase may require several iterations before the optimal solution is identified. The fifth step is to evaluate the merged code and solution performance in the development environment and push the code to the production environment for deployment when all components of the solution are found to work as intended. The sixth and final step of the process is to monitor the solution at scale in a production environment, which includes maintaining a product roadmap, ensuring that sufficient DevOps support is available to handle any technical issues and monitoring the solution quality.

Building a scaled advanced analytics solution in the cloud requires a management process or methodology to govern and monitor the development of the solution. One such methodology is agile. Agile is a popular alternative to the traditional waterfall approach where software solutions are typically built iteratively with minimal documentation written up front, allowing the development team to get feedback iteratively and pivot quickly (eg fail fast). A product owner should oversee the solution development and manage the product roadmap, which will be driven by the business requirements. A methodology such as agile can help support and manage the development process.

Creating a holistic culture with a shared vision and integrated strategic plan, and building the technological and advanced analytics infrastructure to support that plan, cannot happen without significant effort and patience. In reality, depending on the maturity

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**FIGURE 3** Creating an intelligent supply chain through advanced technologies life cycle

Source: Authors
state of the supply chain function and the organisation as a whole, this transformational process may take three to five years to be fully realised. Therefore, those involved (starting with the CEO of the company) must buy into the concept and understand the potential return on investment (ROI) of such a transformation so that they may remain committed to the goal.

CONCLUSIONS

Supply chains commonly experience pain points relating to an absence of a single source of truth, which tends to result from a broader lack of alignment and the existence of functional silos. In addition, managing demand and supply at scale is driven by manual processes and a tendency to be reactive instead of proactive. The first step in transforming the supply chain is to ensure an aligned organisation with shared goals and a strategic vision, which includes having alignment across common objectives. Cross-functional objectives should be shared by all business units and progress towards those objectives should be measured and tied to performance. In addition, education and training should be provided so that all stakeholders can realise the benefits of such collaboration and integration of goals and objectives.

Once the overall strategic vision is adopted by all stakeholders and the various functional goals are aligned, advantaged technologies can be leveraged to provide a platform for proactive decisioning where waste and cost are minimised and profit is maximised. The steps towards building an advanced technology platform to support the implementation of IBP include: 1) getting all of the solution requirements; 2) determining what to build versus what to buy; 3) acquiring, validating, cleaning and integrating all required data; 4) prototyping preliminary solutions to test the analytical rigour of the models (accuracy, run-time and compute cost); 5) deploying the solution in a production environment; and finally 6) monitoring an automated solution at scale. Having a truly collaborative culture with a shared vision and common set of objectives supported with an advanced technology platform allows the organisation to pivot in near-real time to adjust strategies and tactics to shape demand and optimise financial outcomes, based on a single source of truth.

REFERENCES

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