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Essential Information for Planning Supply Chains

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ABOUT THE AUTHOR

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I am the owner of Learn About Logistics https://www.learnaboutlogistics.com/, the specialist online learning provider of practical learning in Supply Chains and Supply Networks, Logistics, Operations Planning and Procurement. My background as a practitioner, consultant and educator uniquely qualifies me to provide this service.

At RMIT University in Melbourne, Australia I developed and presented the largest Logistics post-graduate program in the Asia Pacific region; the program was presented at centres in Melbourne, Singapore and Hong Kong. While at the University I was part-funded as the Ford Motor Company Procurement Fellow. I was later engaged as the Deputy Director of the Institute for Logistics and Supply Chain Management at Victoria University in Melbourne.

My extensive consulting background includes significant high-level roles. As an Associate Director at a global consulting firm, I led teams that assisted clients to improve their logistics operations, strategic procurement and associated IT systems.

Earlier, at a multinational computer company I provided analysis of IT requirements for manufacturing industry customers and project management for implementing ERP/MRP software applications.

My industrial management experience covered industrial engineering, management accounting, purchasing and operations in the shipping, chemical, metals and food industries.

I hold a Master degree in Logistics Management and a first class honours degree in Finance and Accounting. I am certified in Production and Inventory Management (CPIM) and a Certified Purchasing Manager (C.P.M). I am also certified in Assessment and Workplace Training.

I co-authored the book, published by McGraw-Hill in 2011, titled A Framework for Supply Chains – Logistics Operations with an Asia Pacific Perspective (in Australia and New Zealand it is titled A Framework for Supply Chains – Logistics Operations in the Asia Pacific Region). In 2007, I co-authored the book Working Capital: Business Success and Profitability. I was a contributing author for the books Dynamic Supply Chain Alignment – a new business model for peak performance in enterprise supply chains across all geographies (John Gatorna Ed. 2009) and Supply Chain Management – a Procurement Perspective (Pieter Nagel Ed. 2003). I have written articles for the business press and presented papers at conferences in Australia, Asia and Europe.

I am a past president of APICS, the society for supply chain professionals in Australia. The organisation has been renamed the Australian Supply Chain Institute (ASCI).

ESSENTIAL INFORMATION FOR PLANNING SUPPLY CHAINS

The focus of this eBook discusses the necessary information required by Operations Planning, for use in Sales & Operations Planning (S&OP)

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ABOUT SUPPLY CHAINS

Uncertainty and Supply Chains

Uncertainty is a situation of not being confident about what is (or might be) occurring. And that is common for organisations that rely on global supply chains. Even businesses which buy items from a local wholesaler or importer, are reliant on the supply chains of their suppliers, and they could be global.

Uncertainty within a supply chain is the product of Variability in throughput and lead times by the businesses involved, Complexity within and between organisations and Constraints in processes. Although known to exist, these elements are unpredictable because enterprises do not have control over the Flows (of items, money, data and information) through their Extended Supply Chains, upstream from their Tier 1 supplier. Uncertainty can increase about an organisation's supply chains, depending on the willingness to accept:

- Long distances from the organisation to its customers and suppliers
- Low safety margins for lead times, inventory and working capital
- A focus by Operations on speed and efficiency rather than effectiveness. When too much responsiveness is required, the result can be Instability through the supply chains
- Increased complexity of Flows through the supply chains. Flows are Non-linear in their operation, with many 'ifs' and 'thens', as in a Decision Tree diagram
- Knowledge about where Power is exercised (through ownership, control or influence) among the Nodes and Links of the organisation's wider Supply Chains Network
- Knowledge about where Dependency by a supplier exists in the supply chains of a business, either with another business or with a supply chain
- The extent and influence of Power and Dependency may affect the response to a disruption, such as allocation of scarce materials

The Supply Chains group (Procurement, Operations Planning and Logistics) must be positioned for Uncertainty, which is the basis of Risk Management. So, understanding, structuring and managing risks should enable a business to position customer and supplier relationships and internal co-operation as a core strength.

Planning and Supply Chains

Planning and Scheduling requirements are differentiated by the horizon for decisions, and the volume of data and information to be analysed and considered.

- Planning is tactical over the medium term – planning by month from the end of the Sales & Operation Plan (S&OP) 'freeze period', then quarterly to the time period to install new assets.
    - Planning is about resolving conflicts to enable a common understanding in an organisation about the future, and intended outcomes. Its focus is with people and their willingness and capability to collaborate
- Scheduling is operational over the short term – scheduling from the end of the Sales & Operations Execution (S&OE) 'freeze period' by week, to the longest Lead Time for an input item.
    - Scheduling is concerned with any resource that can affect productive output (i.e., machines and their fixtures, people and supplies). It requires a schedule that is detailed and supported by evidence and analysis

Planning is thinking into the future regarding activities required to achieve a desired goal. The process of planning is more important than accuracy of the plan. This is because outputs from the planning process are based on assumptions about the future, which are updated the next month and can change due to unexpected events.

Given the complex nature of supply chains from Tier 'n' suppliers at mines and farms through to the customer's customers, planning Operations within supply chains must provide direction and the likely extent, not absolute accuracy. Are sales likely to increase or decrease; is more capacity required or less, more or less purchases of critical materials and so on.

The objective of S&OP is to enable a balance between expected future demands for the organisation's products and services, the organisation's internal resources and the supply of purchased or intra-company items. Also, that decisions from the S&OP process can be financed.

The current Plan is provided to a period into the future, commencing after the designated S&OP 'freeze' period, in which the Plan can only be changed in exceptional circumstances. The Plan is updated in the period following the 'freeze' period, based on the latest inputs. So, the Plan is an evolving document that enables preparation for future trends and events – it does not require answers to four decimal places.

But importantly, the Sales & Operations Planning (S&OP) process aligns the teams with outcomes, enabling a unified approach to serve customers more effectively. Collaboration between affected teams enables a better understanding of the inputs and influences, leading to agreement on the most likely outcome, or plan. The aim is to be effective in serving customers, which does not require an assumption of complexity that requires a range of computer applications to overcome.

To facilitate the S&OP process is a critical role for Operations Planning, as it establishes the future direction for the business and the outcome becomes the input driver for scheduling Operations. But this can only be achieved by using current data that is trusted.

Data and Information in Supply Chains

Too many articles and conference presentations tell us that having more data and information leads to 'better' decisions, especially if manipulated by Artificial Intelligence (AI). The danger of having more data is that predictions about the future (i.e. forecasts) will have a higher level of confidence concerning their accuracy. But research has identified that increased confidence is not matched by 'better' decisions.

At a time of unpredictability and uncertainty about the behaviour of supply chains, to invest effort in dissecting past performance is a doubtful use of resources. Instead, there is a need for supply chain professionals to work with information that enables an improved understanding about the underlying structure and capability of your organisation's supply chains. This will enable improved planning decisions from the organisation's ability to effectively respond to changes in demand and supply markets.

However, for data to be of value there are a couple of acronyms to remember: CART or clean, accurate, reliable and timely and ROT, to remove 'redundant, obsolete and trivial' data. Also, to recognise that input data from sources that are not controlled by Operations Planning will be a continuing challenge, including data that is missing, not considered, inaccurate and mismatched.

Forty years ago, as part of implementing MRP/ERP systems, the professional organisation APICS presented a course on clean data and accuracy, including a checklist and audit process. The need is no less today, as current articles indicate that the situation about data quality has not improved.

ELEMENTS OF SUPPLY CHAINS

The challenge for supply chain professionals is to understand how their demand and supply chains currently work, the associated risks and potential for disruptions.

The aim of the Supply Chains group is to provide Availability of products for customers. However, Availability is influenced by Uncertainty in your organisation's sales and supply markets, at customers, at contractors and suppliers and internally within your organisation. Uncertainty adds to Complexity in your business, but for a business to be effective, complexity must be reduced in the planning process.

How supply chains are planned must have equal importance to scheduling operations, physical movements and the storage of finished products and inbound items.

The main elements of supply chains are: finished goods inventory, inbound supply items, customer and suppliers. It is these four elements that Operation Planning requires data and information which improves planning decisions.

One aspect is that products for sale and inbound items, customers and suppliers are not homogenous groups that can be planned as one. Each contains patterns of behaviour that require a different technique for planning. Within each element Segmentation is a technique used to differentiate groups:

- Finished goods inventory is segmented to reflect the sales patterns of stock keeping units (SKUs), calculated using the Coefficient of Variance (CoV). The segments enable a structured Coefficient of Variance Management (CoVM) approach, that indicate the outbound supply chains of an organisation
- Inbound supply items are segmented into categories and sub-categories (called Category Management) that can be identified as inbound supply chains
- Customers and Suppliers are segmented to differentiate the level of service provided to customers or expected from suppliers.

How elements are segmented and the number of segments identified will depend on the industry, markets and level of Uncertainty that an organisation works within.

While the selling price of a product or cost of an input item and the total value of financial transactions in a year are valid measures, the non-financial factors must be identified, as these will influence decisions about business relationships.

MEASURE DEMAND AMPLIFICATION

Amplification of demand through a supply chain exists when the orders placed on suppliers have a higher variability than for sales made to buyers (customers). The concept was formalised in the late 1950s by Jay Forrester, and later promoted as the 'Bullwhip effect' by Hau Lee in the 1990s.

Although identified seventy years ago, the main causes of variability remain current:

- *Demand signals:* demand forecasts are updated based on customer and internal sales orders and shipment data, with limited input of external data from the sales channels:
    - Visibility through supply chains is limited: It results in Uncertainty, leading to 'Just in Case' thinking. This is due to an inability to account for Variability, Constraints and Complexity across the Nodes and Links of an organisation's Supply Chains
    - Fluctuating demand can result in underutilized capacity or production bottlenecks that influence quoted lead times
    - Fluctuations in demand can affect relationship with suppliers, especially if they are not capable of responding to large variations in order quantities
    - Supply variability in quantities and time the can result in supply delays
- *Order batching:* generate orders from IT system on a period basis (weekly/monthly) using static safety stock rules; 'hockey stick' sales patterns, where most sales are at the end of month to align with invoicing, or overstocking at month and year end to meet sales and production targets; combining orders to meet volume efficiency targets and order batching due to delays (latency) in a supply chain:
    - Demand latency: The time taken from when an item is sold to a customer/consumer until the order for replacement items is processed
    - Data latency: The time taken for data to move internally and between an increased number of Nodes in a supply chain, due to outsourcing. Data latency and a lack of data synchronization can amplify fluctuations in demand as the requirements move upstream
- *Price fluctuation:* involves 'deals', such as volume buys (also called 'investment buying'), where a lower unit price is offered for higher purchase quantities
    - Incurs storage expenses and increases working capital that affects cash flow
- *Rationing and shortages caused by large buying orders:* customer service decreases if some customers must be rationed to satisfy a large order from one customer. Rather than managing capacity, Operations Planning is more likely to increase lead times

Also, outsourcing and the 'long tail' of products that appeal to small markets causes more variability and requires more inventory – that is cycle inventory, in-transit inventory and safety inventory for supply items.

As each party in a supply chain typically acts independently to optimize its own operations, it is unlikely to consider the effect of decisions on other parties. This reduces responsiveness through a supply chain.

The further upstream a business is located in a supply chain, the more critical it is to understand the consumption trends of end users

Calculate Demand Amplification

The Demand Amplification can be calculated for SKUs by Operations Planning. The Coefficient of Variance (CoV) is calculated for each Node of a supply chain. However, as each Node is an autonomous entity, the calculation is unlikely to be shared with other Nodes in the chain, but that should be an objective.

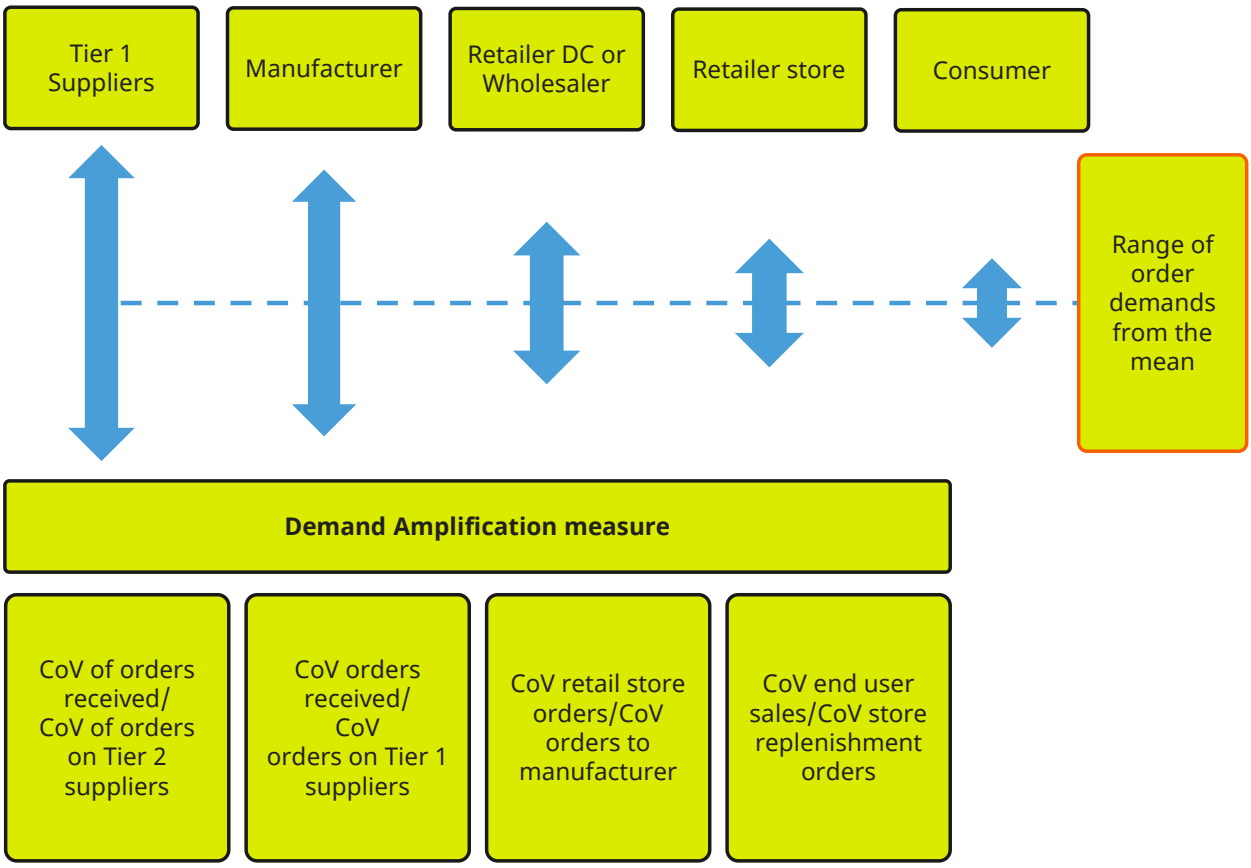


Diagram 1: Demand Amplification (Bullwhip Effect)

Table 1: An example of a CoV calculation is shown below:

Week/Month	Retail sales @ Point of Sale (PoS)	Replenishment orders received from supplier
1	800	1050
2	1200	1000
3	1300	1400
4	1200	3000
5	1100	1000
6	1200	800
7	1300	1350
8	1200	2400
9	1350	1300
10	1300	1200
Mean	1184	1334
Standard Deviation	157	698
CoV (Std. Dev/Mean)	X = 0.13	Y = 0.52
Demand Amplification	(Y-X)/X = 2.94	

Source: How Do You Measure The Bullwhip Effect on Your Business? (linkedin.com)

The Demand Amplification of 2.94 identifies by how much variability at the point of demand is amplified in upstream orders. This result indicates an 'under control' situation for the product line. However, it is the trend rather than absolute figure that is important to review. A decreasing Demand Amplification indicates an improving responsiveness to customer demands. This requires initiatives by the Supply Chains group to reduce the lead times that can be influenced. Examples of initiatives are:

Relations with customers - review with Sales the pattern of customer orders:

- Increased sales at the end of month – 'end of month rush'
- Overstocking at the end of month/year to meet sales and production targets
- Payment terms used by customers as order triggers
- Pricing and price/payment incentives that influence order quantities
- Fixed costs and 'economies of scale' cost structures that encourage large, irregular orders
- Identify the 'Cost to Serve' for customers
- Identify product lines for rationalisation – reduce the cost of complexity caused by the 'long tail' of low selling SKUs
- Implement an Available to Promise (ATP) application as the customer service tool

Product design – review with Marketing and Engineering:

- Design of products for commonality of parts or ingredients
- Enable a delay to the differentiation of SKUs (that is Postponement)
- Identify lot and batch size reduction
    - Evaluate the use of 'quick changeover' tooling for finishing and packing equipment, to enable a faster response against customer demands

Operations Planning:

- Where possible, link Operations Planning directly to external demand signals e.g. if supplying to retail, use retailer's point of sale (POS) data
- Implement inventory control policies e.g. promote vendor managed inventory (VMI)
- Implement Sales & Operations Planning (S&OP) as the tactical planning process for the business
- Use 'Scenario Planning Analysis' and 'Predictive Analysis' as Risk Management tools to identify potential disruptions in supply

Suppliers: Identify where and how to improve trust and contractual agreements. Identify improvements in relationships with non-key suppliers

People: Align management incentive or bonus payments to the required performance objectives – so that 'we behave how we are measured'

These initiatives are required for senior management to be comfortable with the knowledge and performance of the Supply Chains group. This enhances the opportunity for Operations Planning at the Tactical level to provide the corporate input for Scheduling at the Operational level.

SEGMENT OUTBOUND PRODUCTS

Variable Demands in Supply Chains

With increased outsourced production, internal capacity buffers have been removed. Also, in the drive for cost reduction, the higher utilisation of internal machines has resulted in limited spare capacity. This leaves inventory as the buffer against the variability of demands for products from customers and consumers.

In addition to variable demands from end users, there are variable demands for selected stock keeping units (SKUs) imposed by Marketing actions. These include new product introductions, product line extensions (that provide the 'long tail' of inventory), and product promotions.

Planning inventory therefore requires an approach that identifies SKUs with a more stable demand, requiring limited buffers of inventory and capacity. This enables sufficient resources to be deployed for managing products with unpredictable and variable demand.

A standard approach to planning SKUs is through using ABC groups (using the Pareto or 80:20 rule). However, the limitation is that all SKUs within a group are treated the same, even though their pattern of demand will vary. To overcome this limitation requires that Operations Planning implement the statistical technique called Coefficient of Variation (CoV), which identifies the pattern of sales.

Coefficient of Variation (CoV) - an input to Planning

The process commences in Table 2, by listing the title of all SKUs from highest to lowest sales in Column 3, and showing their rolling 12-month sales in Column 4. This will include products with seasonal demands and new products.

Using the Pareto (80:20) rule as the model, the SKUs are split into Groups, extended to Groups A to E, based on the approximate criteria shown in columns 1 and 2 of the Table.

The Table shows a business with seven SKUs in Group 'A', each named as a colour. In Group 'A', it is common that annual sales figures for each SKU are similar.

% of SKU within each Group	% of sales @ COGS value	SKU list	Annual sales in units (most to least)	Mean value of monthly sales	Std. Dev. of sales		Class by CoV result (Std. Deviation/Mean)				
Based on Pareto rule (80:20)			Rolling twelve month sales			**a**: </= 0.25	**b**: >0.25, <0.50	**c**: >0.50, <0.75	**d**: > 0.75, <1.0	**e**: >1.0, <1.5	**f**: >1.5
Group A 15 – 20%	70 – 80	Grey	14,601	1217	756			.6212			
		Pink	14,576	1215	1217					1.00	
		Blue	14,414	1201	300		.2498				
		Yellow	14,286	1191	1155				.9698		
		Green	14,267	1189	381		.3204				
		Black	13,990	1166	554		.4751				
		Red	13,923	1160	165	.1422					
Group B 20 – 30%	10 - 15										
Group C 40 – 65%	5 - 15										
Group D 10 – 15%	5 - 10										
Group E <3%	Nil										

Adapted from data supplied by Tom Rafferty Supply Chain STO Pty. Ltd.

Table 2: Planning Group/Class for SKU Sales

It is often assumed that as each Group 'A' SKU has similar sales, so each should receive the same logistics response for high-volume and predictable products; but this is not so. Products with similar annual sales can have a different pattern of demand.

The CoV for each SKU is calculated by dividing the standard deviation of sales by the mean of sales. The mean of monthly sales for each SKU is shown in column 5 and the Standard Deviation in column 6. The CoV result for each SKU is then allocated to its Class, from 'a' to 'f' in columns 7 to 12. In the Table, the SKUs in Group 'A' are identified by their CoV Group/Class: 'Aa', 'Ab', 'Ac', 'Ad', 'Ae' and if required, 'Af'.

In the Table, SKU 'Red' is in Class 'a', three SKUs (Blue, Green, Black) are in Class 'b' and one SKU is in each of Class 'c', 'd' and 'e', indicating different patterns of sales. Using the same process, the SKUs within Groups B, C, D and E are also allocated to their Class.

In general, businesses are likely to have SKUs across the following allocation:

- A CoV of less than 0.5. High volume and predictable demand in Class 'a' and 'b', Can be forecast using standard time-series forecasting techniques
- A CoV of 0.5 – 1.0. Intermittent volume and demand in Class 'c' and 'd' and
- A CoV greater than 1.0. Low volume and less predictable demand in Class 'e' and 'f'

Management actions based on CoV

When all SKUs have been allocated to their Group/Class, or pattern of demand, the structure will identify the organisation's supply chains. Under the heading of CoV management or CoVM, Table 3 notes the different tactics and actions for each Group/Class. For ease of memorising, Tom Rafferty at STOgroup has identified each of the patterns of demand as either: Steady, Variable, Erratic, Irregular, Lumpy or Dead.

Group/Class & features	Demand (Sales) Planning	Make (Operations Planning)	Source (Procurement) Planning
Class a: STEADY: High volume and predictable. 5% of Sales; 1% of SKUs	Low variation in sales – MAPE 10-15%. Can forecast sales	Tracking signal >4.0 for review of safety stock	Rate based delivery (Just in Time) where possible
Class b: VARIABLE: Reduce time = Responsive 65% of Sales; 5% of SKUs	Variable forecast 'error'; verify sales data with market information; change service levels	Tracking signal >7.0 for review of safety stock; Postponement; Quick machine changeovers	Short lead times; responsive suppliers able to scale. Vendor Managed Inventory (VMI)
Class c: ERRATIC: Products may be managed within a season. 15% of Sales , 5% of SKUs	Some SKU can be high volume, but seasonal. May have low number of customers	Identify cause of *Erratic* demand; pre-build for season - Make To Stock (MTS)	Annual or seasonal buy of dedicated materials
Class d: IRREGULAR: low demand, high variability = Agile SC. Slow & Obsolete SKUs (SLOB) 5% of Sales, 10% of SKUs	SLOB: no sales in 6 of past 12 months. Rationalise products; review service level & minimum order quantity if imported	Postponement at late stage. Assemble To Order (ATO). May contract production to specialised company	Tend to low quantity PO; standardise materials in use. Vendor Managed Inventory (VMI)
Class e: LUMPY: Low sales but can be predictable. SLOB SKUs. 5-7% of Sales, Up to 70% of SKUs	Not traditional demand forecast method. Product rationalisation needed	Quick changeovers: finite scheduling: review constraints and decoupling points	Short lead times; responsive suppliers able to scale. Hold consignment stock
Class f: DEAD: Delete if no sales in past 12 months. Also: New product launch & Promotion giveaway	New product launch or Promotion giveaway. Initial volume high, then could become LUMPY category.	Sales market data convert to inventory plan; contract packing for promotions	Initial buy from responsive suppliers able to scale

Based on 'CoVM Categories' developed by Tom Rafferty Supply Chain STO Pty. Ltd.

Table 3: CoVM Analysis for Operations Planning

STEADY and VARIABLE Group/Class: Demand is steady with low variation, regardless of the volume sold or used. These SKUs are planned as 'Make to Stock' (MTS), but with a reasonably steady demand, a high service level will not require a high physical safety stock. In a typical FMCG or CPG business less than 20 percent of SKUs can be forecast using traditional time-series approaches. The mechanism for management of these SKUs is Tracking the accuracy of forecasts, calculated as the Cumulative Variance (for each of the periods between forecast and actual sales) divided by the Standard Deviation.

For SKUs in the STEADY Group/Class, a Tracking Signal of less than 4.0 indicates the SKU forecast is in control. In the VARIABLE Group/Class, this calculated figure will be up to 7.0. When the Tracking Signal exceeds 4.0 for STEADY and 7.0 for VARIABLE, it is the trigger for a review of the forecast parameters, including the allocated service level.

ERRATIC Group/Class: these SKUs can have high sales, but monthly volumes vary substantially. Sales of these products is often to a small number of customers. The Supply Chains group must work with Sales to understand the drivers for each customer's pattern of orders (such as seasonal demand) and causes of variability.

IRREGULAR (purchased by customers in small quantities on an irregular basis), LUMPY (up to 70 percent of SKUs) and DEAD: These are called 'Slow and Obsolete' (or SLOB) stock. They often represent too much inventory sitting in warehouses gathering dust and costing money. For example, at one consumer goods company, SLOB stock represented 4 percent of sales value but 24 percent of inventory value.

ERRATIC, IRREGULAR, LUMPY and DEAD Group/Class. These SKUs are unlikely to be forecast with any accuracy using standard time-series forecasting techniques. As many companies use this technique for all SKUs, excess safety stock is more likely with the associated inventory risks.

Marketing and Sales often resist rationalising product lines. The Supply Chains group must therefore have a product line elimination strategy within the inventory management process. New product launches, promotions and give-aways must have the total cost identified and tracked.

Other things to consider

While CoV is the logical approach to structuring SKU inventory, additional decision criteria can be used to place an SKU in its appropriate Group/Class. Depending on the business and type of products, these criteria can include:

- total cost of ownership for the SKU
- total cost of a stock-out for the SKU (including reputational damage)
- product range integrity – to obtain the sale of a fast-moving SKU, particular slow-moving items must also be available to make a 'packaged' sale. These assumptions must be questioned
- physical size of the finished product
- risk of pilferage for the SKU or input materials
- shelf life and batch control requirements
- availability of specialist resources for the SKU to be produced
- storage requirements for finished products or materials e.g. very low temperature
- engineering or technical design complexity for SKU modifications
- high Procurement risks when buying specific materials or components

Segmenting SKUs by Group/Class commences the process of defining your organisation's outbound supply chains, with each having its flows of production, inventory and delivery characteristics. Organising SKUs into this structure provides the means to establish an inventory policy for your organisation, based on facts rather than opinions.

SEGMENT CUSTOMERS USING COST TO SERVE

Not all customers want or need the same level of service, but many companies do not know the service requirements of their customers, although often assume they do. Identifying the 'Cost to Serve' (CTS or C2S) is a process to correct this situation.

If sales are made to customers without knowing the total cost of the business relationship, there are two major risks:

1. selling more products to a customer that is thought to be profitable, but is not
2. to negotiate for higher levels of service with customers that already incur an unknown high cost to serve

The CTS process is to identify customer related activities that occur due to the specific needs of a customer. These are pre- and post-sales costs plus the steps from when their purchase order is received to when payment is banked.

Customers are then segmented for the required level of service, based on their 'Cost to Serve' and Gross Margin.

Customer profitability

The traditional accounting approach has the profitability of a customer calculated at the Gross Margin level. Table 4 illustrates the accounting profitability of two customers, 'A' and 'B':

	Customer 'A'	Customer 'B'
Sales to customer	$500,000	$520,000
Cost of Goods Sold	$250,000	$260,000
Gross Margin	$250,000	$260,000
Overhead @ 30% of sales	$150,000	$166,000
Operating profit	$100,000	$94,000
Profit percentage on sales	20.0%	18.08%

Table 4: Customer 'A' and 'B' profitability

The approach of allocating an arbitrary overhead percentage hides the actual overhead costs incurred to serve that customer (or a distribution channel or market segment). This can lead to assumptions that customers with a 'better' gross margin are those to hold and develop. Instead, a customer service profile is required that identifies the additional activities required for the customer.

Customer 'A' service profile	Customer 'B' service profile
Expects the sales representative to be available on-call	Requires limited sales and technical support
Requires a high level of technical assistance	Requires a low level of technical assistance
Orders multiple products in small lot sizes at random intervals	Orders a small range of products in large lot sizes at regular intervals
Likely to change the order mix, requiring additional work by customer service and distribution	Rarely changes the order mix
Expects fast delivery from time of order	Accepts reasonable delivery times
Located more than 200km from the distribution centre, with no other customers nearby	Located less than 100km from the distribution centre
Average of 65 days to pay their 'net 30 days' account	Average of 42 days to pay their 'net 30 days' account

Table 5: Customers 'A' and 'B' service profile

Even without a financial analysis, the profiles indicate that the 'cost to serve' for Customer 'A' is higher than for Customer 'B'. For a more accurate approach the overhead costs would be allocated, based on an Activity Based Costing (ABC) analysis. However, at the initial stage, a proposal from the Supply Chains group to use CTS is unlikely to gain support from senior management, given the resources required to collect and manage the data.

An alternative approach

Before expanding the ABC analysis scope, it is preferable to keep the initiative within the Supply Chains group. Input from Marketing and Accounting will be on an 'as required' basis, therefore it will not require extensive effort. The initial step is to identify the cost elements for CTS. Examples of costs that can be attributable to a customer are:

- Pre-sales costs: sales calls and visits; to develop and provide quotations
- Sales costs: account management time; order processing costs; price discounts provided
- Storage and Handling costs: Dedicated warehouse space required; dedicated inventory; order size and likely product range; special order handling and storage e.g. refrigeration; non-standard packaging; special documentation e.g. external quality certification
- Delivery costs: delivery lead time and customer access times limited due to traffic congestion; express transport requirement
- After-sales costs: returns due to changed customer requirements; refusal of product e.g. not arrived within the customer allocated time slot; additional customer service time incurred; trade credit – the actual payment period. For retail customers, additional after-sales costs are in-store promotions and merchandising

Within each heading, a weighted score is devised so that each customer CTS score is based on the same criteria. Customers are segmented by gross margin weighted by CTS score.

The objective of CTS is to ensure that all customers are profitable. From the analysis process identify:

- *low margin, high CTS customers:* small orders and spending low amounts but having special service requirements
- *'over-serviced' customers:* consider alternative distribution service; reduce services offered or adjust pricing to improve profitability
- *high-cost processes:* identify reasons for high level of returns; packaging/packing requirements

Gathering the initial data is led by Logistics and the data entry should be a spreadsheet task. Because changes to your organisation's supply chains and customer markets can affect the CTS for certain customers, updates must be ongoing, therefore a dedicated IT application can be considered.

SEGMENT INBOUND SUPPLY ITEMS

The global trading situation contains multiple risks, so not understanding your organisation's core and extended inbound supply chains is a risk to the business. A knowledge of supply markets, supply items and suppliers enable Procurement professionals to structure the most appropriate relationships with selected suppliers.

The link between Operations Planning and Procurement is the Bill of Materials (BoM). Within the BoM, the critical materials and intermediate goods are highlighted, based on data from the Procurement Category Management process. Using this information, the availability of critical supply items can be identified within the S&OP process.

Risks in inbound supply chains

Identifying, analysing and managing risks in inbound supply chains must be a core capability of the Supply Chains group, with Procurement as the lead specialist. For inbound supply items, the two guiding criteria are:

1. Availability of supply: Supply Chains can be disrupted by geopolitical events, and with the imposition of import and export bans, tariff and non-tariff regulations or quantity quotas. Also, trade regulations concerning import and export duties, dumping and embargoes, plus technical regulations affecting building permits for suppliers and IT interoperability with suppliers.
2. Vulnerability to supply: The potential of Tier 1 suppliers unable to obtain sufficient intermediate items from their suppliers or having a material in short supply. This can be due to the Tier 1 business being reliant on a few suppliers or that potential suppliers are in the same geographic area, which is a 'concentration of supply' risk.

On a country basis, strategic dependency can be identified when imports of a particular good (or item) is available from less than three exporting countries. Or more than 50 percent of the country's supplies come from any one country and that country controls more than 30 percent of the global market for that item. If this situation may affect a business, Procurement must consider the importance of the supply item in development of future products and technologies and whether the current import can be substituted or new production technologies become available that remove the dependency.

Supply Chain risks within four criteria:

1. *Supply Chains Network Design* risks within the 'Core' and 'Extended' inbound and outbound supply chains. There are a wide range of risks to consider e.g.
    a. Availability and Vulnerability of supply for a Category/sub-Category
    b. Outsourcing and offshoring: transparency, response times, security and intellectual property
    c. Cyber-attack at your organisation, customers and suppliers that can affect communication, data integrity and operations within your organisation's Supply Chains
    d. Reputation impacts for the organisation. For example, if a supplier at Tier 3 or 4 in a supply market uses child labour
2. *External risks to the supply chains* from interactions between a location (inventory Node or transport Link in a supply chain) and the wider environment. Risks are summarised under the acronym of PESTEL: (Geo)-Political; Economic; Social; Technological; Environmental (i.e. ESG) and Legal.
    a. (Geo) Political: Territorial claims by countries that may affect transport movements. National governments may increase protection for selected industrial sectors, which can influence supply chains, through providing subsidies, concessions, local content rules and direct investment
    b. Economic: International and domestic government economic policies and actions. At country level it can affect profitable revenue and the cost of doing business
    c. Social: Changing demographics among consumers. Identify the origin of products and ingredients ('clean and green'). Employment and labour conditions in countries
    d. Technological: Availability and implementation of IT and telecommunication technologies; the potential of disruptive technologies in a country
    e. Environmental: Climate Change regulations; carbon emissions standards; use of eco-friendly packaging; potential of moving towards a 'circular economy' for products at 'end of life'; availability and price of utilities (water, electricity and gas); renewable energy expectations
    f. Legal: International and country-based laws and International Trade agreements
3. *Internal (enterprise) risks* to the supply chains.
    a. Multiple supply chain risks (which are 'connected' risks) are not consolidated due to a lack of cross discipline knowledge
4. *Internal Supply Chain process risks* that constrain the business from achieving consistent outcomes relating to planning and scheduling the movement and storage of materials.
    a. Risks within Procurement
    b. Risks within Operations Planning
    c. Risks within Logistics

The approach to risk evaluation is guided by how senior managers view risk in relation to the business; summarised as:

- **Risk appetite:** amount and type of risk the organisation is prepared to pursue and accept and
- **Risk tolerance:** capability of the organisation to withstand the effects of the accepted risks

Analysis process

The process for analysing inbound supply commences with identifying input supply items as 'direct expense', that is supplied by a 'Supply Industry' or an 'indirect expense', supplied by a 'Service Provider'. The next step, shown in Diagram 2, is to place the items into their respective supply group, and then allocate the groups into their appropriate supply Category and sub-Category.

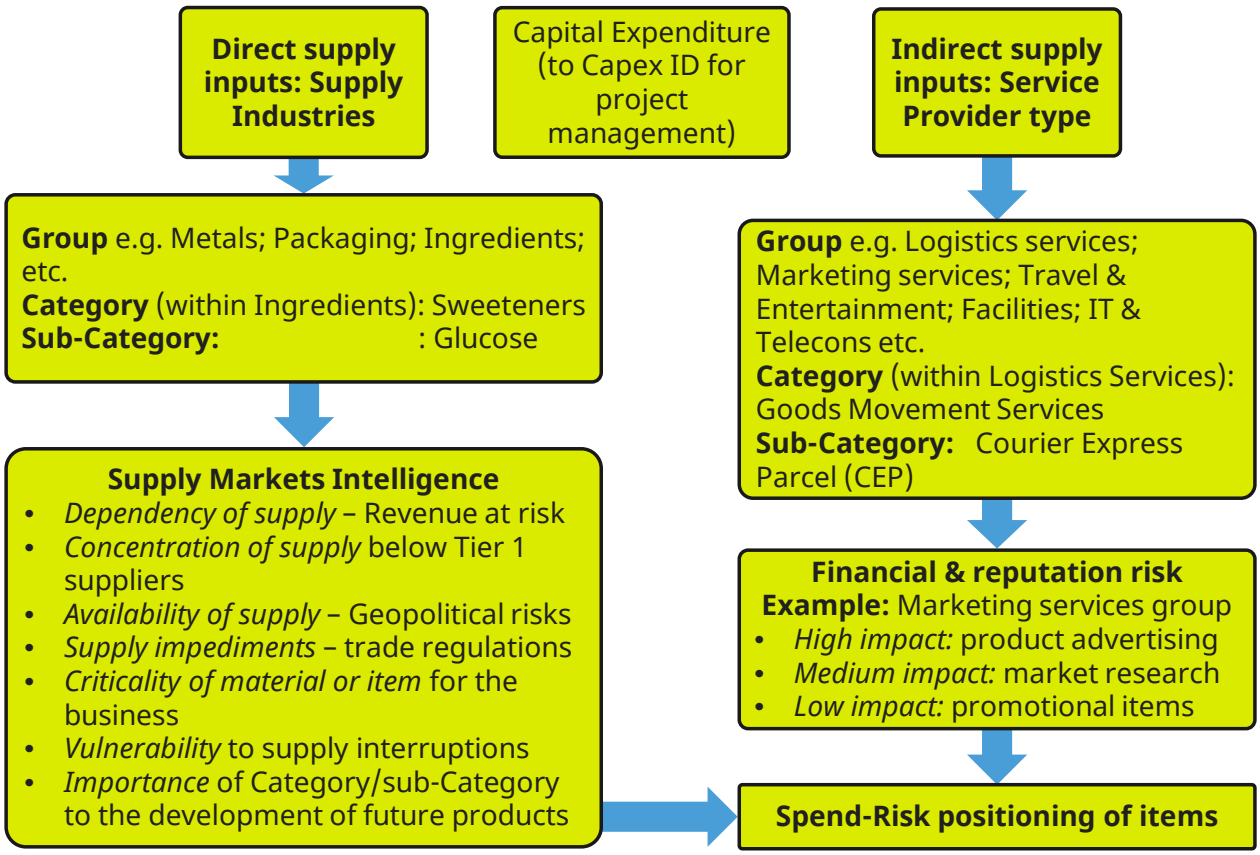


Diagram 2: Procurement Category Segment Structure

The diagram has the supply industry as food

- the Group is Ingredients
- the Category is Sweetener
- the sub-Category is Glucose

Within indirect supply:

- the Group is Logistics Services
- the Category is Goods Movement Services
- the sub-Category is Courier Express Parcel (CEP)

For an automotive business, the example can be:
Within Supply Industry:

- the Group is Electronics
- the Category is Semiconductors
- the sub-Categories are: microprocessors, memory chips, commodity integrated circuits and 'systems on a chip'

continued...

Within Service Provider type:

- the group is Facilities
- the Category is Industrial supplies
- the sub-Category is Safety glasses

Following the Segmentation of inbound supply items, the risks associated with each Category or sub-Category must be identified. This is because an organisation's revenue can be affected to the same extent by not having supply of a low-cost item or a high-cost item.

Under 'Service Provider', Diagram 2 identifies a risk factor as the potential financial and reputation impact if the buying process goes wrong. Like the risks for material items, these risks are scored. To mitigate the risk, sourcing plans will incorporate possible action:

- high impact - product advertising: a comprehensive global sourcing plan, with the horizon of three to five years
- medium impact - market research: an abridged regional sourcing plan for the next 12-18 months and
- low impact - promotional items (giveaways): a country tactical negotiating plan

Spend Analysis identifies the pattern of spend in Operations, via direct and indirect expenditure for purchased items and individual suppliers. Diagram 3 shows the *Cost Map Analysis* supplied by Accounts Payables.

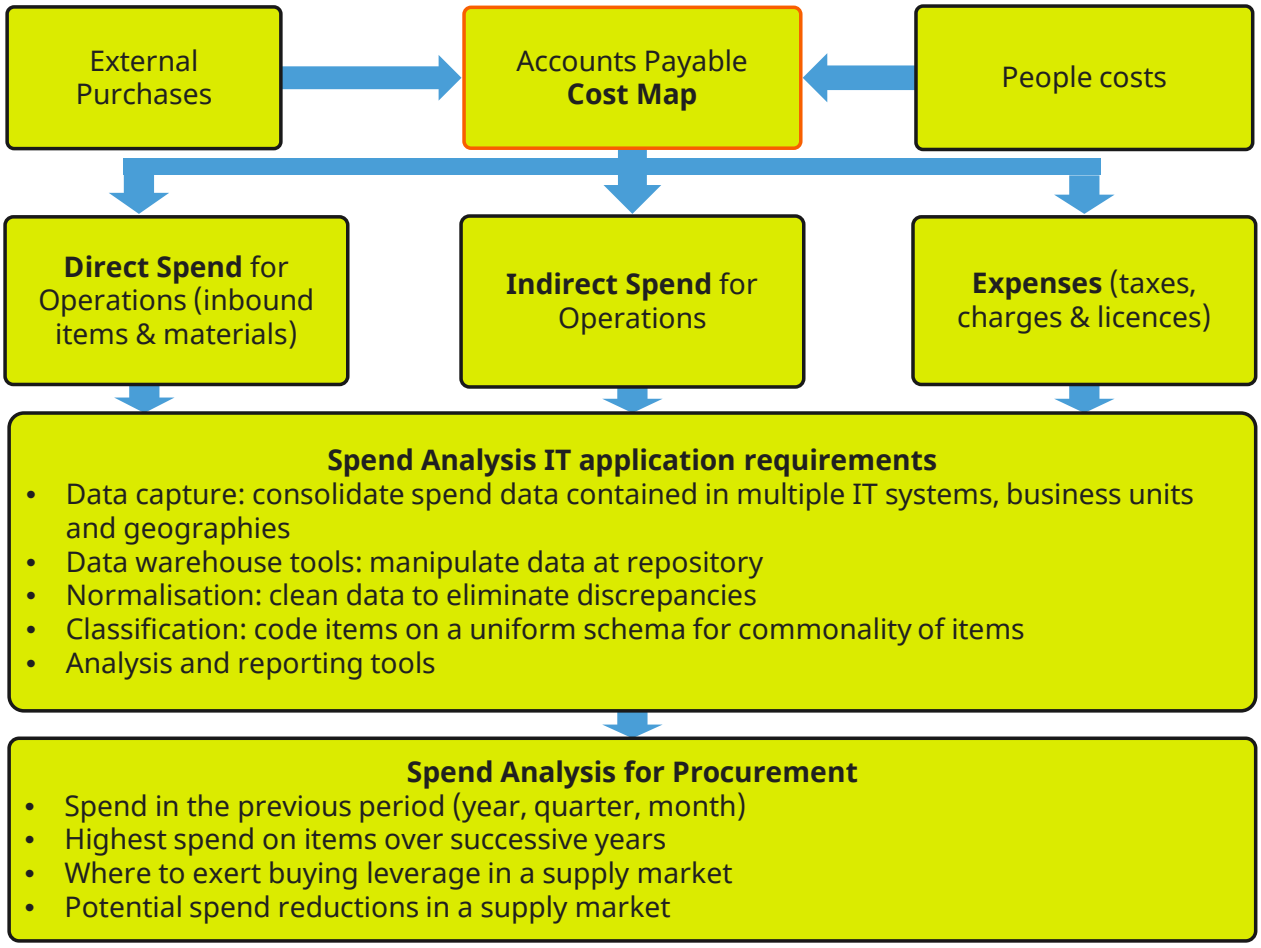
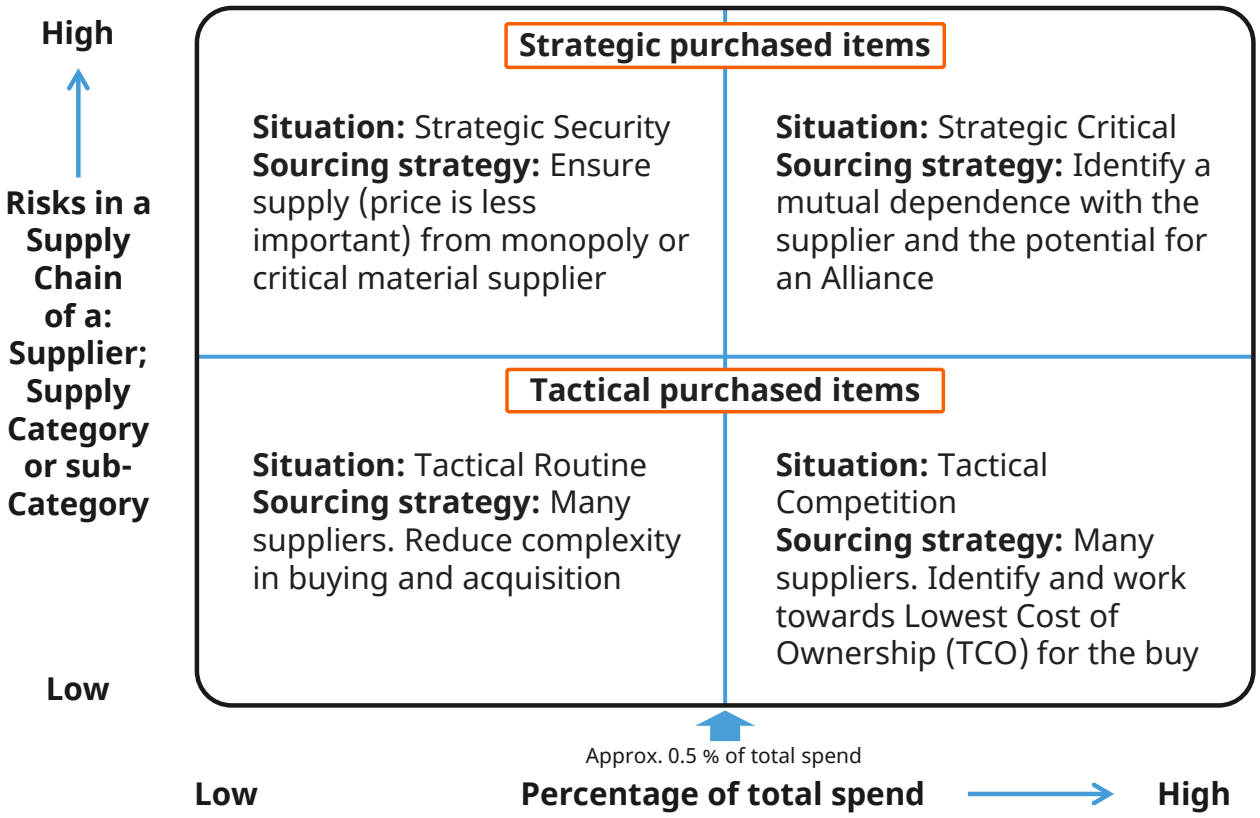


Diagram 3: Cost Map Analysis

To enable analysis through the Cost Map, the accounts must be cleaned of discrepancies (called Normalisation) and classified within a coding system. Discrepancies that are important for Procurement are:

- Suppliers can trade under multiple division and business names, although ultimately owned or controlled by one entity. A supplier's name can therefore be entered differently in the Accounts Payable files. For example, Ford Motor Company and Ford Australia
- Dates to be standardised, as they can be written dd/mm/yyyy, or mm/dd/yyyy, or yyyy/mm/dd
- City names can be written differently e.g. New York, or NY, or NY NY
- Multiple general ledger and cost centre names
- Categories and standard industry (SIC) codes may be used in one part of the organisation, but not others
- Descriptions of the product or service can vary, depending on the user

Given that the Spend and Risks associated with inbound supply have been analysed and scored, the items are then located in the 'Spend – Risk Positioning' matrix, shown in Diagram 4.



Adapted from Kraljic 1983

Diagram 4: 'Spend-Risk' Analysis

The Spend-Risk analysis identifies the preferred supplier relationship structure required for a supplier, Supply Category, sub-Category, item or material. To identify the best supplier relationship, the Spend-Risk analysis is compared with an analysis of the likely response to the business opportunity by a potential supplier.

This is explained in the section ***Spend-Risk Evaluation of Suppliers***, with ***Diagram 6: Supplier's View of a customer (the buyer organisation)***

Know your supply markets

Not understanding your organisation's supply markets is a risk to the business. Procurement's responsibility is to progressively investigate the supply markets and suppliers (current and potential) by Tier, to ascertain the risks, power imbalances and dependencies.

Many global supply risks are also within domestic supply. Products purchased domestically will often include materials or items manufactured internationally but sold domestically by country sales divisions of the brand business, importers and agents.

Supply Markets Intelligence (SMI) is the term used for the analysis of supply markets. This includes knowledge of: location (of supply facilities and input materials), risk of non-supply; reliability of supply, visibility of actions and sustainable processes.

Surveys conducted by the supply chains risk firm Resilinc indicate that even well-resourced companies are likely to know the production location details for only about 50 percent of their Tier 1 suppliers; less than 20 percent of Tier 2 suppliers and much less than 5 percent of Tier 3 suppliers. Yet it is at these lower Tiers where the risks to supply are highest.

The objective is to gain an improved understanding of the wider risks associated with the organisation's supply markets and trade lanes. SMI enables an assessment concerning: Resilience of supply markets, Criticality for the business of a Category or sub-Category and the Vulnerability of the business to the supply of strategic and critical materials.

As previously noted, the Supply Markets risks are scored according to the organisation's:

- **Risk appetite**: amount and type of risk the organisation is prepared to pursue and accept and
- **Risk tolerance**: capability of the organisation to withstand the effects of the accepted risks

Annual spend for an item is not a valid measure, as spend does not equate to risks.

To Segment inbound supply requires an understanding of supply markets and a meaningful Sourcing Plan for inbound materials and intermediate items. Although a business can buy items without following the outlined process, the risk of 'things going wrong' can increase substantially in an uncertain world.

SEGMENT SERVICE PARTS

An additional group of inbound material items for some businesses is Service Parts. These are either for sale to customers as part of the business (mainly in the automotive, white goods, aerospace and industrial equipment industries), or used within a company's own facilities as service parts for operational equipment. For example, a large mine site for extracting minerals may hold over 30,000 different service parts, with a need to review more than 100 relevant part numbers per day.

Service Parts can also be held as 'insurance parts' to ensure their availability after production of the finished product is discontinued. These parts are often held in inventory as higher assemblies, such as a full gearbox rather than each of the component parts. The final order for an 'insurance part' to be held in inventory is called 'life of type' (LOT) or 'all time buy' (ATB).

Segmenting service parts inventory is based on the Criticality of each part, as shown in Table 6. For the more critical parts, the Mean Time Between Failure (MTBF) is calculated from historical records and applied to the part.

Criticality	Service level	LT>90 days. Single supplier	LT>30 days. Single supplier	LT<30 days. Single supplier	LT<30 days. Multiple suppliers	LT<7 days. Multiple suppliers
Catastrophic failure (can kill people or affect business viability)	99%+	Aa	Ab	Ac	Ad	Ae
Operational failure (severely affect customer service or the provision of services)	98%	Ba	Bb	Bc	Bd	Be
Operational impairment (reduces the effectiveness and performance of staff)	95%	Ca	Cb	Cc	Cd	Ce
Non-service/Non-critical (Out of Stock (OOS) will not cause significant problems)	84%	Da	Db	Dc	Dd	De

Table 6: Segment Service Parts

Service parts held for sale can remain in inventory for extended periods before a sale occurs. Therefore, a business needs to know whether holding the part is earning a return for the company. The calculation for this is the 'gross margin return on inventory investment' (GMROII), calculated as: Gross margin x Inventory turns/1 – Gross margin. Given the costs associated with holding inventory, a business should expect to earn about three dollars (or equivalent in local currency) for each dollar invested in service parts inventory.

SEGMENT SUPPLIERS

Supply Chains cannot be managed. The role of supply chain professionals is to understand their organisation's supply chains. This includes the likely responses and actions to unplanned events and disruptions by suppliers and providers of supply chain services.

The response to a disruption will reflect the situation and risks at the supplying business. The risks within the organisation's supply chains are unlikely to be considered, and it does not depend on the Tier of supplier. It will reflect the power that the supplying business is able to exert within its supply chains, or the level of dependency it has on its customers and supply chains.

Structuring supplier risks

To convert Uncertainty into Risk requires Procurement to evaluate, analyse and rank Uncertainties concerning suppliers. The initial step is to place an Uncertainty within one of four classifications that are identified below.

Some possible risks are identified, but there are others. Checklists are available, but each business must structure its own and provide the relevant weighted scoresheet. Of less importance is the annual spend that an organisation has with a Tier 1 supplier. A small supplier which provides a critical part or ingredient may have a risk profile equal in score to a large supplier.

The four Risk classifications at suppliers are:

1. **Supplier Internal risks**
    a. **Supplier's Financial Risks**:
        i. Financial security and solvency
        ii. Costs incurred by buyer for cancellation or delay of an order
        iii. Global suppliers: currency and exchange rate, country inflation, interest rates
    b. **Supplier's Operational Risks**:
        i. Capability of consistent supply (delivery in full, on time, with accuracy – DIFOTA).
        ii. Capability of supplier when it is affected by a disruption in its supply chains
        iii. Management of supply contracts with multiple customers (the buyers). Competition for capacity resources at a supplier that may affect deliveries
        iv. Volume/capacity commitments with supplier's suppliers
        v. Manufacturing capability:
            i. Time required to allocate additional capacity to meet a buyer's demand surge

continued...

vi. Operations planning capability:
   a) S&OP implementation status
vii. Customer service escalation process
viii. Product development capability and lead times

c. **Supplier's Contractual relationship risks**:
   i. Supplier's capability for leverage against the buyer (i.e. power)
   ii. Dependency by the supplier on the buyers
   iii. Dependency by the supplier on its suppliers
   iv. Preparedness to negotiate 'total cost of ownership' with buyers. Allocation of risk between the seller and buyer and willingness of the supplier to share risk and reward with buyers
   v. Data security: Buyer's data security at supplier
   vi. Intellectual Property (IP): supplier's access to buyer's proprietary knowledge regarding design, materials and technical/operations
   vii. Extent of complying with ESG (Environment, Social, Governance) regulations and requirements:
      a) Environment: How the supplier evaluates an environmental risk it may face and how it manages the risk. Is the supplier using 'nature capital' to assist with investment and financial decisions?
      b) Social: Business relationship with suppliers and their suppliers (i.e. the extended supply chains). Working conditions of supplier's employees and at their suppliers. Community living conditions at supplier locations
      c) Governance: Supplier's leadership structure, independence of directors, executive remuneration, internal controls against illegal and unethical practices

2. **Supplier's Location risks:**
   a. **Major weather events:** storms (hurricane, cyclone, typhoon), tornadoes, hailstorms, floods and coastal storm surges
   b. **Geological events:** earthquakes and volcanoes
   c. **Operating risks:** traffic congestion for access to operations, ports and distribution centres; power supply availability
   d. **Concentration risks** of similar suppliers at the location

continued...

3. **Supplier's Supply Chain risks.** Identify potential risks from the following list:
   a. **Connected Risk**: an event that disrupts one part of a supply chain flows to other parts of the Supply Network, which can then interact dependently, independently and inter-dependently to affect outcomes
   b. **Interdependent risks**: events (e.g. shortage of a raw material) in an industry sector or at Tier 2, 3 or 4 suppliers may affect demand and supply in other industry sectors that supply your business
   c. **Contingent Risk**: events within a supplier's business that could affect a supply chain e.g.
      i. fire at a material supplier or cargo theft from a 3PL
      ii. concentration of assets along supply chains, such as Hub Ports and Logistics Hubs
      iii. licence to operate a commercial business issued (and can be withdrawn) by a national government
   d. **Emerging Risk**: developments that may change demand and supply factors within an industry sector or at a supplier of supply items for your organisation

4. **Supplier's External risks:** contained within the acronym PESTEL: (geo)Political; Economic; Social; Technological; Environmental; Legal. These have previously been discussed in the section Segment Inbound Supply Items.

Weighted Supplier risk in segments

Risk Evaluation in the centre of the diagram illustrates the flow for assessing risk, utilising the four Risk Classifications.

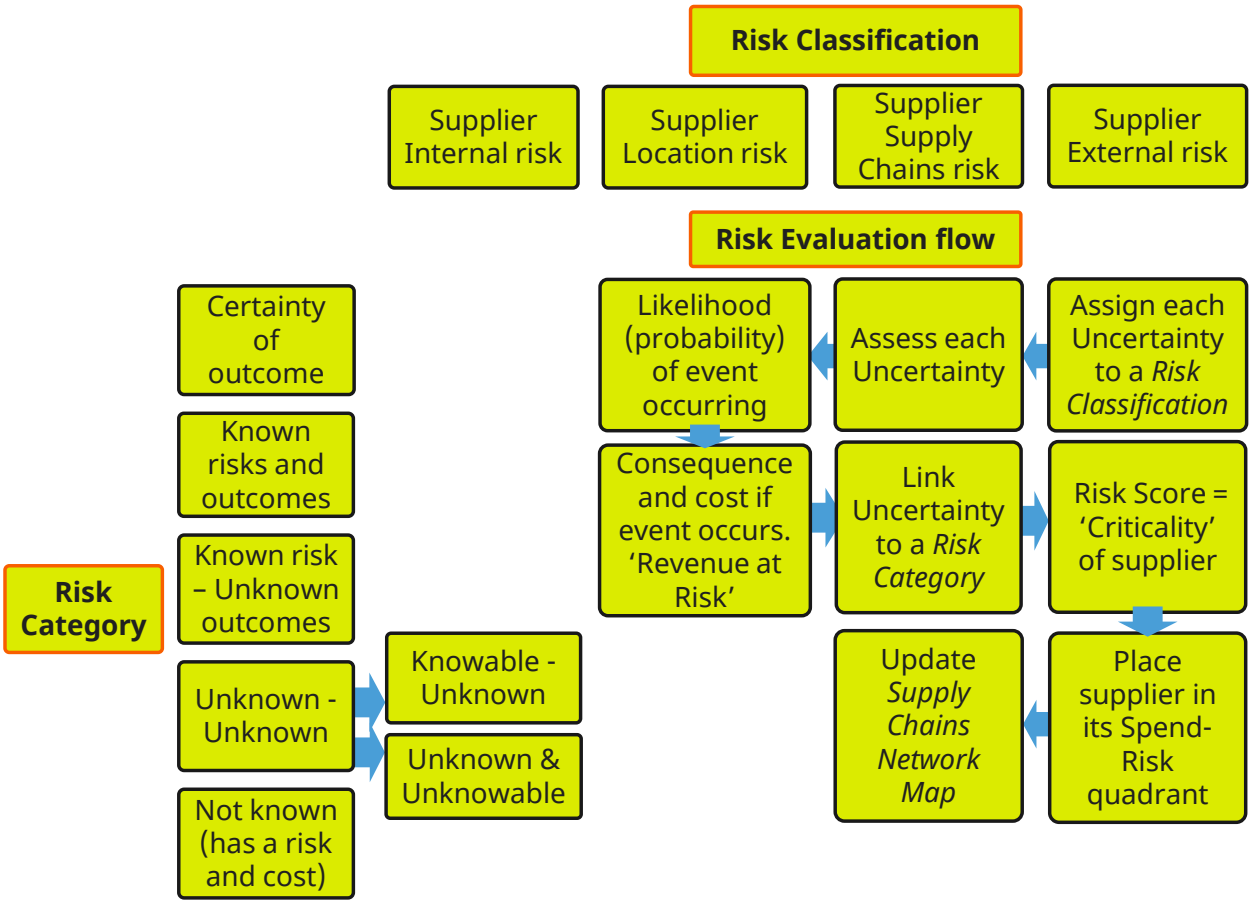
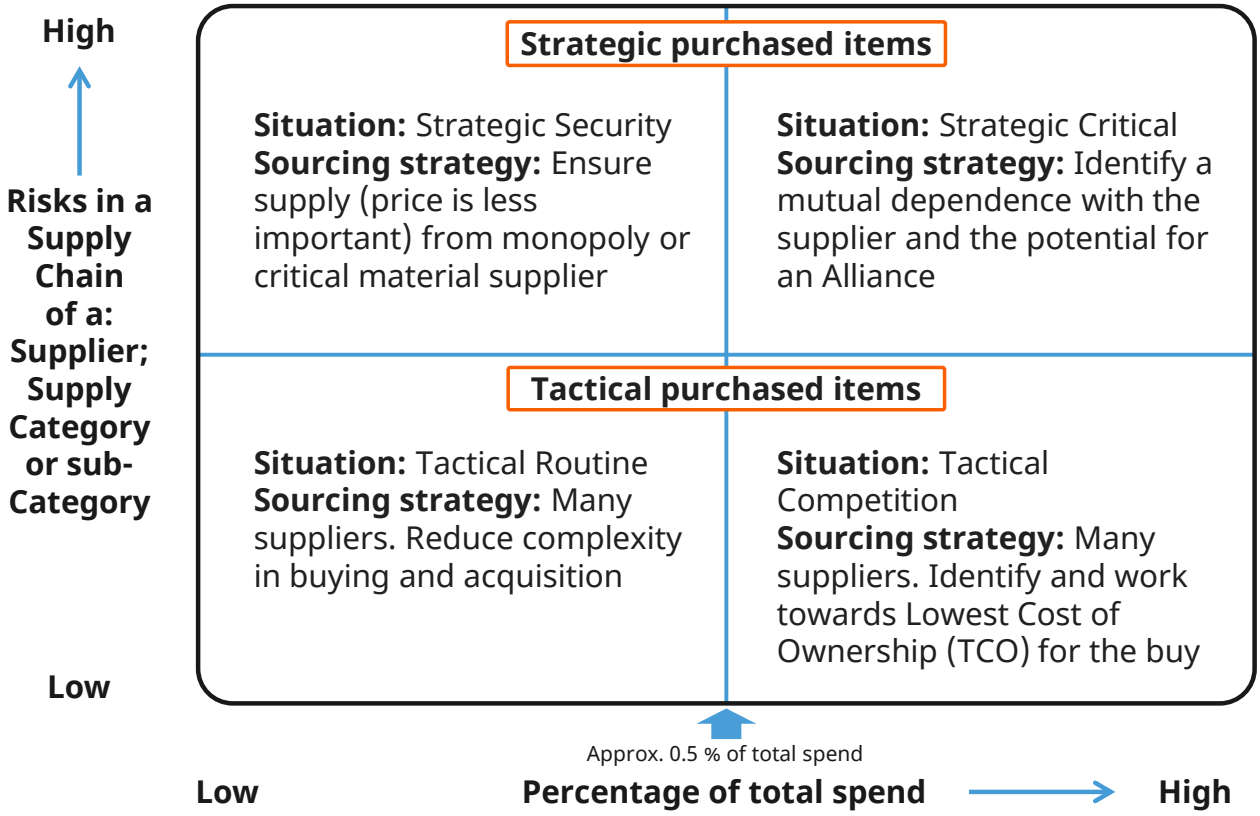


Diagram 5: Risk Evaluation Process for Supplier Segmentation

Each Tier 1 supplier is evaluated against the *Likelihood* (probability) of each event occurring and the *Consequences* and cost if the event occurs. The cost is measured as the potential 'Revenue at Risk'. The Likelihood and Consequences score provide the weighted risk score, which is allocated to a Risk Category. The scores for each risk element within a Risk Classification are then aggregated to a total score for the supplier, which is transferred to the Spend-Risk Analysis.



Adapted from Kraljic 1983

Diagram 4 (repeated): 'Spend – Risk' Analysis

Diagram 4 is shown as a quadrant, but it can be expanded as required. On the Y axis, the level of risk is identified in the range of scores. Each supplier is allocated to a quadrant, depending on the percentage of total annual spend and the risk score. This identifies the segment into which a supplier fits, which corresponds to the type of business relationship required.

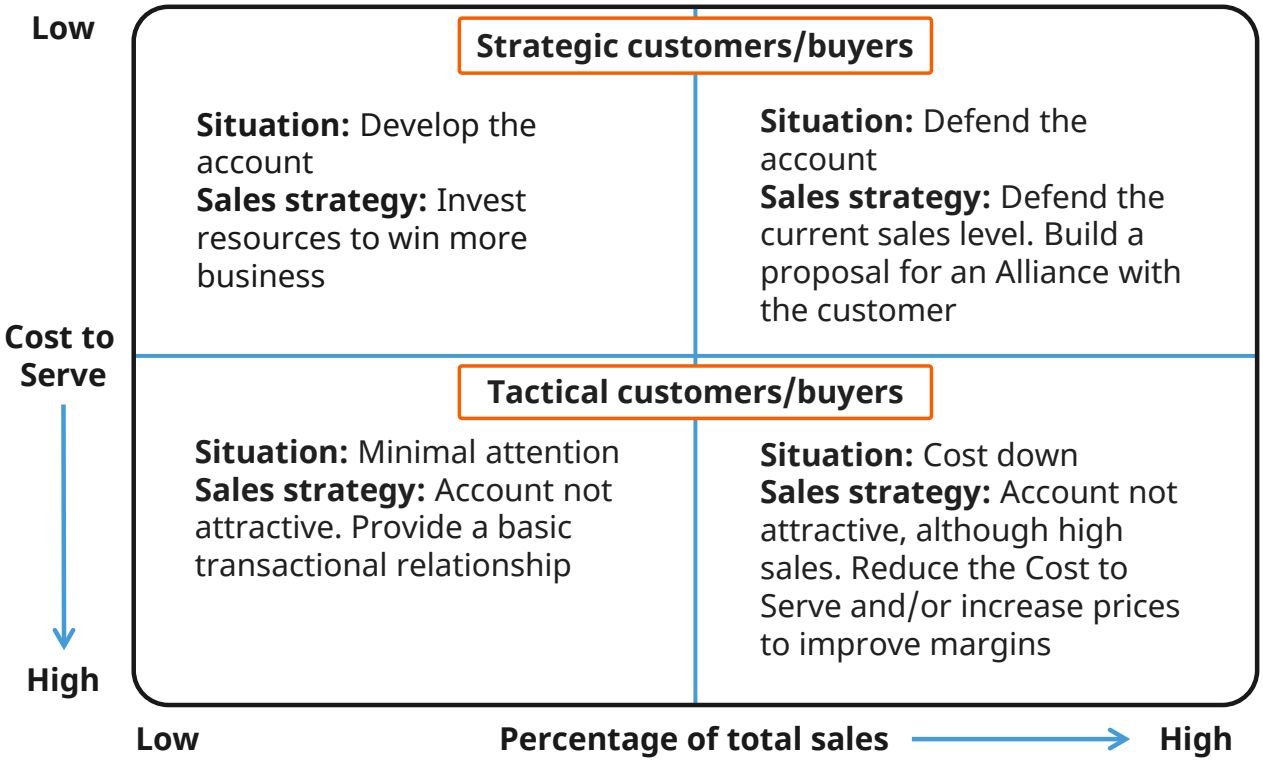
The steps identified through a Risk Evaluation for Tier 1 suppliers supports turning Uncertainties into calculated Risks, which are allocated to segments for managing the relationship. This is an improvement on building relationships only with suppliers that incur a high annual spend, but not with small suppliers that are potentially critical to the buying business.

Spend-Risk Analysis of Suppliers

As the risks increase, so a supplier becomes more critical to the buying organisation.

- For items in the Tactical Routine and Tactical Competition quadrants, a portfolio approach to the risks is used. Total the commitments with suppliers by geography - region, country or city
- For items within Strategic Security, the sourcing strategy is to ensure supply and for Strategic Critical it is to build mutual dependence. The criticality of a supplier is based on the Availability and Vulnerability of supplied items.

Having completed the Spend-Risk Analysis, Procurement reviews current and potential suppliers' likely views about a supply relationship. Diagram 6 is an application of Game Theory, whereby Procurement professionals at the buyer take on the role of sales staff at the supplier. The two criteria for consideration are the percentage of total sales that the supplier has (or may have) with the buyer and the likely Cost to Serve the buyer.



Adapted from Steele & Court 1996

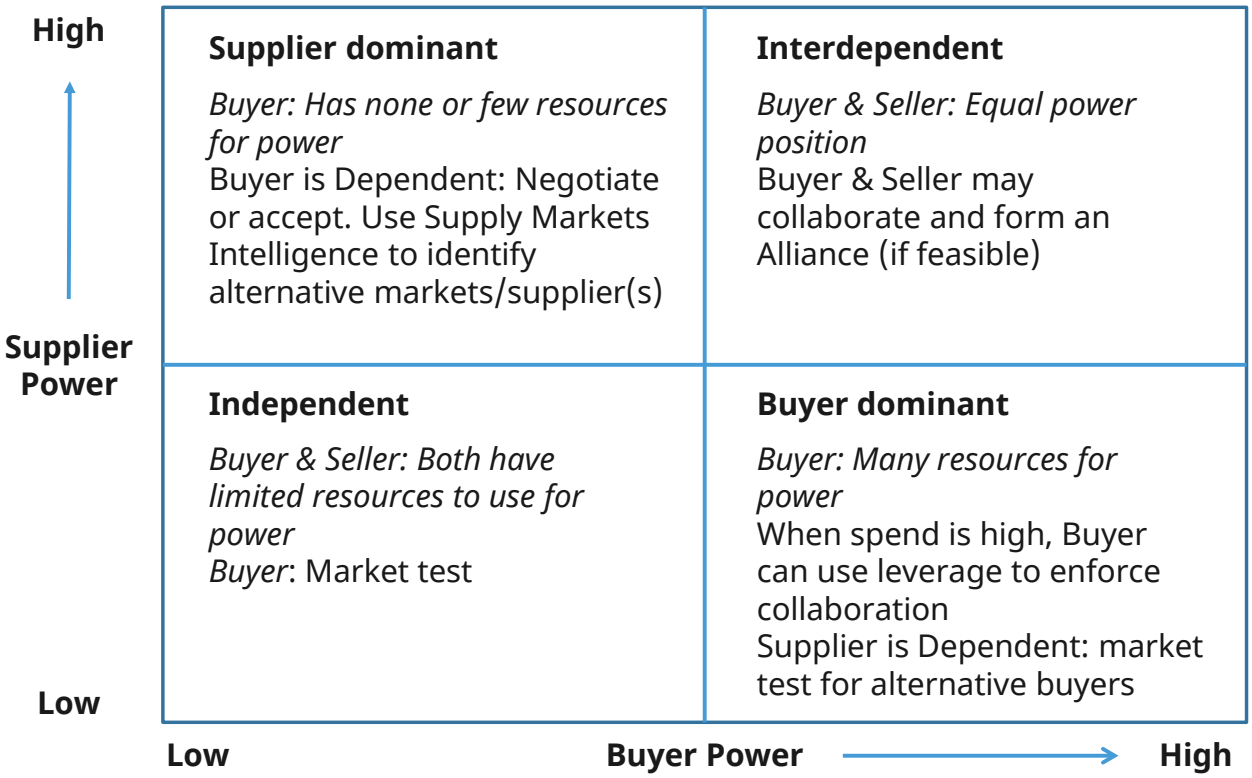
Diagram 6: Supplier's View of a customer (the buyer organisation)

Match the Quadrants

The most preferable response of a supplier is to mirror the buyer's needs. For example, if the buyer has placed office stationery as Competitive Routine (Spend-Risk quadrant 1), the ideal match is that a supplier views the buyer as core business to defend (Supplier Positioning Quadrant 4). In this situation, the supplier will provide a high level of customer service under a period contract.

Conversely, challenges will occur for the buyer if they are viewed as Minimal Attention (Supplier Positioning Quadrant 1). Neither the buyer or supplier will put resources and effort into the contract, so the business relationship is likely to be acrimonious.

In addition to assessing the risks, Procurement must identify where Power or Dependency has a role in relationships at specific inventory Nodes and transport Links in the Supply Chains Network. This is because these influences may affect the response to a disruption, such as the allocation of scarce materials by a supplier, or a powerful customer unilaterally extends payment terms for a supplier.



Adapted from Cox A. Strategic Sourcing (2008)

Diagram 7: Power and Business Relationships

In these situations, customers and suppliers in a competitive supply market must accept a new situation, but those buying or supplying items in a monopoly/duopoly situation will be treated differently.

Following the analysis of Tier 1 suppliers, modelling buyer-supplier risk and power/dependency positions can be done for Tier 2 and below through the supply chains. The results will improve as the quality of data and information is enhanced.

SEGMENT SKUs FOR SALES & OPERATIONS PLANNING (S&OP)

Output from Operations governs what a business can sell. The volume of a stock keeping unit (SKU) that can be produced is governed by constraints in the production process, so SKUs are segmented by capacity limitations:

- SKUs are placed into product 'families'
- An S&OP family is identified for each applicable SKU by its capacity utilisation at 'bottleneck' resources within Operations
    - Product 'families' within a business can also reflect the brands or models that are supplied to major customers, such as 'private label' products for supermarket chains and items supplied to automotive assemblers
    - The number of families can vary between 5 and 15, depending on the type of business. However, the typical range is between 6 and 12

The S&OP reviews for both 'Sales' and 'Operations' are undertaken by each product family. A standard unit of measure for the data provides a consistent base for communication across all functions and entities. The standard could be: equivalent shipper (carton size shipped to customers); tonnes; litres; pallets; direct hours etc.

Additional Data for Sales & Operations Planning (S&OP)

In preparation for each Sales & Operations Planning (S&OP) process, Operations Planning will have additional information concerning supply markets and the SKUs that have been segmented into 'product families'. This will most likely be a mix of relevant data and information that is both 'push' (or 'inside-out') and 'pull' (or 'outside-in'). Not all needs to be analysed; some is 'nice to have' or for reference.

Push or Inside-out data and information

- internal data concerning incoming orders and orders from Sales; deliveries to customers; list prices and discount criteria; seasonality of product sales, public holiday calendar; product promotions calendar, and other relevant characteristics

Pull or Outside-in data and information

- data on consumer purchases, either from retailers' point-of-sale equipment or sold by retail sales data companies
- macroeconomic information that informs consumer behaviour and trends. Includes: government provided economic data e.g. GDP, CPI, rates of unemployment and inflation; retail sales; housing sales and building approvals. Reports published by firms that sell economic forecasts
- external data and information that provides indications of consumer sentiment and likely demand. Includes: geopolitical events and forecasts; natural disasters that may affect supply; competitor actions; analysis of references in social media to identified industries, companies and products; analysis of searches on the company's web site; weather forecasts

SUPPLY CHAINS NETWORK DESIGN MAP

The Map is a home for the data and information required by Operations Planning for the Sales & Operations Planning (S&OP) process.

Why is a Map needed?

Because each customer and supplier is an independent organisation with their own business objectives and policies, a supply chains network will not become 'integrated'. Instead, there is a need to build a 'body of knowledge' about customers, suppliers and supply markets on which your organisation relies.

By acquiring data and information from Tier 1 suppliers, an assumption can be formed that supply chains risk has been reduced. But less known is from where the Tier 1 suppliers obtain their inputs and so on through the Tiers of suppliers.

Although an item may be available from several suppliers, each could be reliant on one or a few suppliers at Tier 3 or 4 levels of their supply chains. Examples are: speciality alloys, special purpose adhesives and coatings and substrates used in packaging. The supply of an item to your Tier 2 suppliers can stop without your organisation being aware of the cause.

So, the challenge for supply chain professionals is to understand how the demand and supply chains are currently structured and operate, together with the associated risks and potential for disruptions. This 'knowledge bank' is contained in a Supply Chains Network Design Map, also called a Supply Chains Map.

What is in a Supply Chains Map?

The corporate ERP system will contain header information and transaction details concerning each Tier 1 supplier. But it is unlikely to hold details about the location and operations of the supplier's factories that provide the required items. It is at this level of detail that input data is required for a Supply Chains Map.

The Map for an organisation is developed from Flows (of items, money, data and information) that travel between the customer's customers of an organisation and the farms and mines where inbound materials commence. Flows are enabled by the transfer of inbound supply items and outbound products through transport Links between the physical Nodes of a supply chain.

- Nodes: each location that holds material items, money, data or information. Identify the suppliers' locations for manufacturing and warehouse/distribution centres (including outsourced) and the customers' warehouse and distribution facility locations. Note their capability, including capacity and responsiveness. Also identify the transport Nodes used, such as sea and airports, transport hubs and intermodal terminals. Note constraints such as load capacity and container/pack size limitations.
    - Variables: are factors that can change the physical or financial value of items and money at a Node
    - Flows between Nodes may contain time periods, or 'buckets' to allow for seasonality and inventory pre-build
    - Throughput is best expressed as a standard unit of measure e.g. tonnes, shippers, litres, hours, pallets, loads etc.
- Links: movements of materials and items by transport mode between Nodes. Identify features such as: seasonal and other demand patterns; lead times; cross-border requirements; potential bottlenecks and wait times at country borders and organisations that own, control or influence critical Links
- Time to Recover (TTR): expected if critical supplier Nodes or transport Links become unavailable

For outbound supply chains there is additional information supplied by Marketing and Sales concerning the 'competitive edge' of the business: Customer Service expectations; expected latency of order and delivery data.

Additional data and information is entered that reflects the item's origin, such as country of origin (which may differ from the location where it becomes a manufactured product), currency exchange risk and government restrictions. Also, data provided from the Segmentation analysis of elements within supply chains.

The Supply Chains Map for your organisation provides input to the Sales & Operations Plan, so will require data needed for planning the business. Examples are:

- Location: Tier 1 suppliers; owned and contracted production and distribution locations ownership
    - assumed linkages between Tiers 1,2 and 3 suppliers and between customer's customers;
    - ownership, control or influence at Nodes and Links;
    - contractual responsibilities at Nodes and Links;
    - risk to facilities from natural events: storms, floods and forest/bushfires;
    - plans for power requirements using renewable technologies and capacity to comply with pollution reduction laws
- Materials: inventory form and function at locations; conflict minerals identification
- Operations measurements: such as order and delivery latency; lead times, inventory, which vary depending on demand and supply uncertainties
- Environment, Social and Governance (ESG) legislation compliance

This 'part-location' mapping enables your organisation to identify a specific site affected by a disruption and which intermediate goods, parts or materials could be affected and delayed.

Construct the Map

The construction of the Map is led by Procurement for inbound supply and Logistics for outbound distribution. The Supply Chains Map can be shown either as a geographical or abstract design.

The first step in the Supply Chains Mapping process is to 'reverse engineer' your organisation's products. This is to identify all items used – component parts, materials or ingredients, down to the lowest Tier of supply. This enables an extended Bill of Materials to be constructed for each product group.

The lower the supply Tier for a material or item, the more difficult it is to influence any changes directly with the Tier 1 suppliers. However, the knowledge gained enables investigation to commence for alternative materials and supply chains.

Building the Map is building a Network, comprising the linkages between parties that can influence the plans and schedules of your organisation. Ideally this requires an IT application for building a Map, which becomes the core reference for inputs to undertake analytics of the inbound and outbound supply chains.

Your organisation's Supply Chains Map is a 'living' document, which reflects the current supplier and customer supply chains network to enable Availability of finished goods for customers and consumers. The Supply Chains Map is therefore regularly updated, to ensure that it reflects the changing situation in supply chains.

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