

CONSTRUCTION SUPPLY CHAIN MANAGEMENT

Introduction to supply chain management and SCOR model

The supply chain is a network of facilities that produce raw material, transform them into intermediate goods and then final products, and deliver products to customers through a distribution system. The supply chain network structure is composed by three structural dimensions:

- Length: number of tiers across the supply chain
- Width: number of suppliers/customers represented within each tier
- Company's position: within the supply chain

Supply chain management's relationships

1. Logistics and transportation
2. Operations management
3. Purchasing and supply
4. Marketing
5. Industrial economics and organization
6. System dynamics

Flows related to the supply chain

1. **Physical flow – goods flow**: it goes from upstream to downstream of the supply chain; in other words, it goes from raw material to the final products.
 $\rightarrow S \rightarrow M \rightarrow D \rightarrow \text{MARKET}$ (Supply side = materials - Demand side = just finished product flow)
2. **Information or planning flows**: it goes from downstream to upstream; in other words, it goes from the market to the production.
 $\rightarrow \text{MARKET} \rightarrow D \rightarrow M \rightarrow S \rightarrow$
3. **Cash flow – financial flow – money flow – invoices flow - transaction flow**: supply chain finance tools involve also insurance or electronic platform that provides financial transactions. The focus on finance supply chain is the inventory; it covers the difference between physical flow and cash flow. Inventory concerns safety stock to prevent from unexpected events, cycle stock that is the amount of stock needed to the cycle and the speculative stock that allows to use an excess of cash in raw material rather than in another field.

Supply chain characteristics

- Organization
- Related to 3 flow: physical, information and cash
- Related to processes and activities: activities + execution + enabling
- Customer = the king of the supply chain
- Visibility: related to getting information for customer; it is the main ingredient to reduce the bullwhip effect.

Why supply chain management is relevant?

1. **Evolution / problems upstream**
 - Outsourcing: take resources from outside + outsourcing of logistic place
 - Offshoring: you move your business into other country. It is similar to outsourcing, but you move far away. Usually the causes for offshoring are economical or legally.
 - Offloading: practice related to aggregate planning; sub-supplier and delegating work.
2. **Evolution / problems downstream**
 - Explosion and "volatility" in customer requirements. It increases variety. Volatility is related to frozen period, increasing pressure under the frozen period and that the customer is willing to change idea next to the due date.
 - New products and process technologies: to meet requirements and to reduce the frozen period.
 - Request for faster processes: you have to react
 - Internationalization and market globalization

The SCOR model

SCOR = supply chain operations reference

The SCOR model has been developed and endorsed by the supply chain council as the cross-industry standard for supply chain management. The supply chain council is an independent not-for-profit organization dedicated to the development, promotion and support of SCOR as the cross-industry standard and it was established in 1996.

The SCOR model contains:

- **Processes:** standard description of management processes and framework of relationship among the standard processes.
- **Performance:** standard metrics to measure process performance
- **Practices:** management practices that produce best-in-class performance
- **People:** training and skills requirement aligned with processes, best practices and metrics.

The SCOR is based on operation processes:

- All customer interaction, from order entry through paid invoice
- All physical material transactions, from your supplier's supplier to your customer's customer, including equipment, supplies, software etc.
- All market interactions, from understating of aggregate demand to the fulfillment of each order.

N.B. SCOR doesn't include: sales administration processes, technology development processes, product and process design and development processes and post-delivery customer support operations including technical support processes.

SCOR is based on 5 more management processes:

1. **Plan:** processes that balance aggregate demand and supply to develop a course of action which best meets the established business rules.
2. **Source:** processes that procure goods and services to meet planned or actual demand
3. **Make:** processes that transform goods to a finished state to meet planned or actual demand
4. **Deliver:** processes that provide finished goods and services to meet planned or actual demand, typically including order management, transportation management and distribution management.
5. **Return:** processes that return goods to supplier or receive goods returned from customers.

→ source, make, deliver and return are called execution process and are triggered by plan (push) or customer orders (pull).

SCOR model levels

- 1° LEVEL – Processes: defines the scope and content for the SCOR.
- 2° LEVEL – Configuration level: companies implement their operations strategy through the configuration they choose for their supply chain.
- 3° LEVEL – Process element level: process element definitions. Process element information inputs and output, process performance metrics, best practices.
- 4° LEVEL – Implementation level: enabler design level

Models for supply chain strategy – Fisher’s model and Hau Lee’s model

Strategy:

- Time-wise = long term (>1 year)
- Space-wise = involving the entire organization

Supply chain internal and external alignment

- **Internal alignment:** means all the supply chain processes according to the scot model. It is consistent.
- **External alignment:** focuses to upstream process to the downstream model.

Alignment is different for product types and yields different processes:

- **Mass product:** is standard product and is characterized by a mass distribution; it has **stable demand** and it refers to long life cycle like supermarkets. Stability generates long term margin prospective and competition that tends to reduce margin. It is characterized by two different cases:
 - Speculative purchasing: means you tend to use your financial strength to keep your competitors in weak position. It’s a typical upstream operation.
 - Sales purchasing: it’s a typical downstream operation.

The idea of alignment means that stable demand requires stable processes that are characterized in general by:

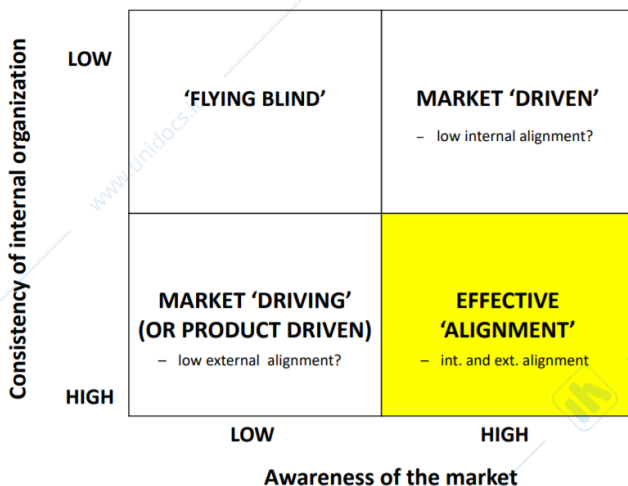
- Nature processes that not innovative
- Automation: along the financial flow or on the production flow
- Medium and long-term supply contract.

→ the idea is to avoid any kind of risk. Here customers are very well known and stable means effective.

- **Innovative products:** are characterized by short life cycle measured in week or month, they have a **variable demand**, high margin that means 200% like pharmacy industry. It has short time windows so if you miss the windows you are late. It has to be short as you can.

The idea of alignment means innovative process that requires unstable process, that concerns risky process. It means that you should be ready to remake your project according to the evolution of technology and production process. You just have one supplier and you have to chase your supply. Than you have short supply contracts: you are supposed to change your supplier contract every 1 or 2 seasons.

→ unstable demand means that you have to reconfigure that.



- **Flying blind:** most dangerous, you don't know your customer and the consistency of market.
- **Market driving:** you have a stablish organization, but you don't know who your customer is.
- **Effective alignment;** you know who your customer is and you are able to create consistency organization.

We can check if the alignment is ok but what else should be considered to define an effective supply chain strategy?

→ Fisher’s model: the first step in devising an effective supply chain strategy is to consider the nature of the demand for the product.

Fisher's model

The Fisher's model of supply chain strategy is to classify products depending on nature of demand. You have to organize your product according to the character of the demand. Demand could be characterized by different point:

<u>Predictable</u>	<u>Demand</u>	<u>Unpredictable</u>
Long (>2year)	Product lifecycle	Short (3-12 months)
Low (5-20%)	Contribution margin	High (20-60%)
Low (10-20 variants per category)	Variety	High (<i>often millions of variants per category</i>)
Low (about 10%)	Average forecast error	High (40-60%)
Low (1-2%)	Average stockout rate	High (10-40%)
0	End of season markdown	High (10-25%)
6 months- 1 year	Leadtime for MTO product	1 days-2 weeks

What is the right supply chain for your product?

→fisher's model analyzes product typology

<u>Functional-mass product</u>		<u>Innovative product</u>
Supply <u>predictable demand</u> efficiently at the <u>lower cost</u>	Primary purpose	Respond quickly to unpredictable demand: minimize stockout, markdowns and obsolete
High average utilization rate	Manufacturing focus	Excess buffer capacity
Generate high returns and <u>minimize inventory</u>	Inventory strategy	Deploy significant buffer stock of parts
Shorten LT al long as it doesn't increase cost	Leadtime focus	Invest aggressively in ways to reduce lead time
Depending on cost and quality	Supplier selection	Depending on speed, flexibility and quality
Maximize performance and minimize cost	Product design strategy	Modular design → postpone product differentiation.
Physically efficient SC Requires efficient SC and stable processes	← Supply chain →	Market responsive SC Requires unstable process

	Functional product-mass product	Innovative products
Efficient SC (stable)	match	Mismatch = fail
Responsive SC (unstable)	Mismatch = fail	match

Summery product typologies

Functional product	Innovative product
<i>Low demand uncertainties</i>	<i>High demand uncertainty</i>
<i>Predictable demand</i>	<i>Difficult to forecast</i>
<i>Stable demand</i>	<i>Variable demand</i>
<i>Long product life</i>	<i>Short selling season</i>
<i>Low inventory cost</i>	<i>High inventory cost</i>
<i>Low profit margin</i>	<i>High profit margins</i>
<i>Low product variety</i>	<i>High product variety</i>
<i>Higher volume per SKU</i>	<i>Low volume per SKU</i>
<i>Low stockout cost</i>	<i>High stockout cost</i>
<i>Low obsolescence</i>	<i>High obsolescence</i>

Hau lee's model

It's an evolution of Fisher's model. It doesn't focus just product's characteristic but also the process typologies.

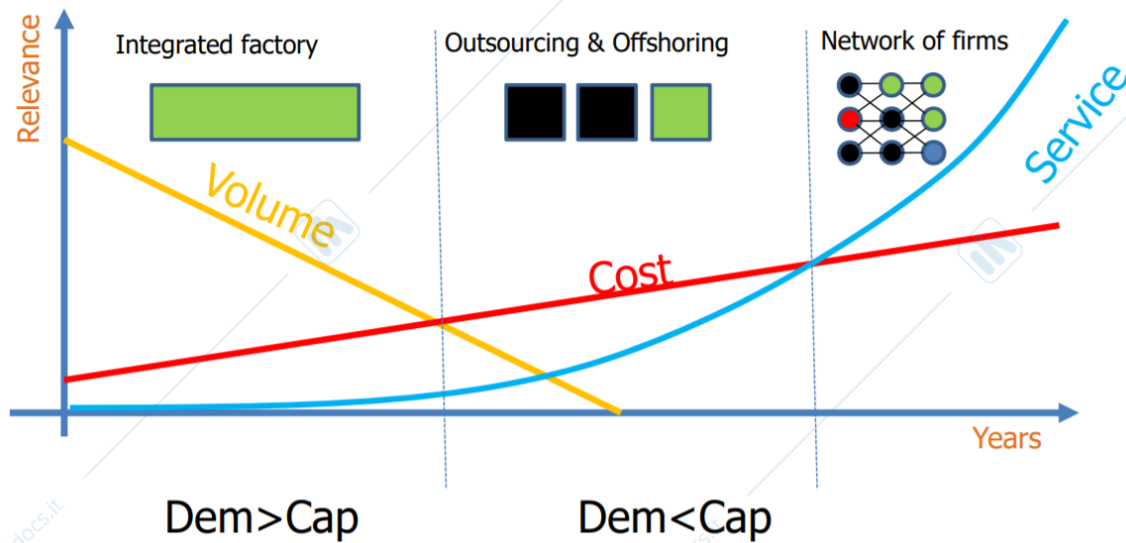
Stable process	Unstable process
Nature process and technologies	Technology and production processes evolution
Clear supply system	Unstable supply system
Automation	Continuous operation fine-tuning, variable productivity
Medium-long term supply contract	Spot supply contracts or frequent specification changes
Less breakdowns = limited failure	Vulnerable to breakdowns
Stable and higher yields	Variable and lower yields
Less quality problems	Potential quality problems
Reliable suppliers	Unreliable suppliers
Less process changes	More process changes
Less capacity constraint	Potential capacity constrained
Easier to changeover	Difficult to changeover
Flexible	inflexible
Dependable lead time	Variable lead time
More supply sources	Limited supply sources

Hau lee's model strategy

	Low demand uncertainty = functional product	High demand uncertainty = innovative product
Low supply uncertainty = stable process	<p><u>LEAN SUPPLY CHAINS:</u> create highest cost efficiency along supply chain</p> <p>→ mass product, very stable = cost efficiency</p> <p>→ maximize efficiency in term of total logistic costs: economies of scale, stock control and centralized management, distribution and production capacity maximization and sharing automation</p> <p><i>Example: food, oil, gas</i></p>	<p><u>RESPONSIVE SUPPLY CHAIN:</u> responsive and flexible to changing and diverse customer needs.</p> <p>→ strategy base on reactivity and flexibility in order to cope with customer's needs variety and variability</p> <p><i>Example: fashion apparel, computers</i></p>
High supply uncertainty = unstable process	<p><u>RISK HEDGING SUPPLY CHAIN:</u> pool and share resources to share risks in supply distribution.</p> <p>→ risk reduction</p> <p><i>Example: agriculture products</i></p>	<p><u>AGILE SUPPLY CHAIN:</u> reactive and flexible + pool supply-related risks.</p> <p>→ capacity of response and flexibility to market needs plus risk hedging strategies.</p> <p><i>Example: telecom, semiconductor</i></p>

Global supply chain planning

It refers mainly to the physical flow of goods. We are talking about something to the network design that is related to the foot-printing supply chain that means how and where to place warehousing all over the worlds.



- **Integrated factory:** solution useful when the demand exceeds the capacity. Here the problem is fulfilling the demand.
- **Outsourcing and offshoring:** solution useful when the capacity exceeds the demand. Here the problem is to fulfill the demand at a lower cost.
- **Network of firms:** you need a network design when you have to make the product more attractive with respect to others. (servitization= increasing service component + selling a product through a service)

Model of global supply chain strategy

0. Local supply chain: local source, for local plants that serve local markets.

1. Low cost supply chain: dislocated sources that serve the same dislocated plants that serve a single local market. The market is very specific but the company needs the help of others countries. (example: Indesit company for washing machines).
2. Low cost plus: dislocated sources for dislocated plants that serves a single local market.
3. Cloners: replication of local supply chain with multi-country operations. This organization is useful for company that produce fresh or heavy products as cement and soft drink. (ex: coca cola).

4. Barons or sellers of made-in: local source for local plants that serve global markets. (ex: luxury goods).
5. Product-focused factories: manufacturing sites with local supply, distribution of the products worldwide. Sites very often are specialized on one or few products or families. (ex: automotive industry with JIT suppliers).
6. Concentration of supply: supplier with a strong specific know-how. Local source for dislocated plant that serve the same dislocated market. (ex: sony)
7. Focused factory and concentration of supply: supplier with a strong specific know-how. The main problem is again the risk for concentration of supplier and concentration of manufacturing. (ex: electronic company).
8. Shoppers: suppling around the world with the same dislocated plants and markets.
9. Octopus: dislocated sources that serve a single plant that serve dislocated markets. (ex. Aerospace, supercomputing).
10. Full global players: dislocated source for dislocated plants that serve dislocated markets.

Purchasing and make or buy

- Purchasing: relates to a close relationship between customers and suppliers
- Buying: you emphasizes the transactional meaning
- Procuring: relates to the strategic area of a company that manage what to purchase and what to sell.

Make or buy? Whenever competences are inside the company is make, if they are outside it's buy. If your success depends just on your suppliers, your ability is the ability to connect customers and supplier, that is a purchasing relation.

Economic theory tells us when the conditions for outsourcing do exist, managements theory tell us when outsourcing is convenient and how to manage relationships with suppliers.

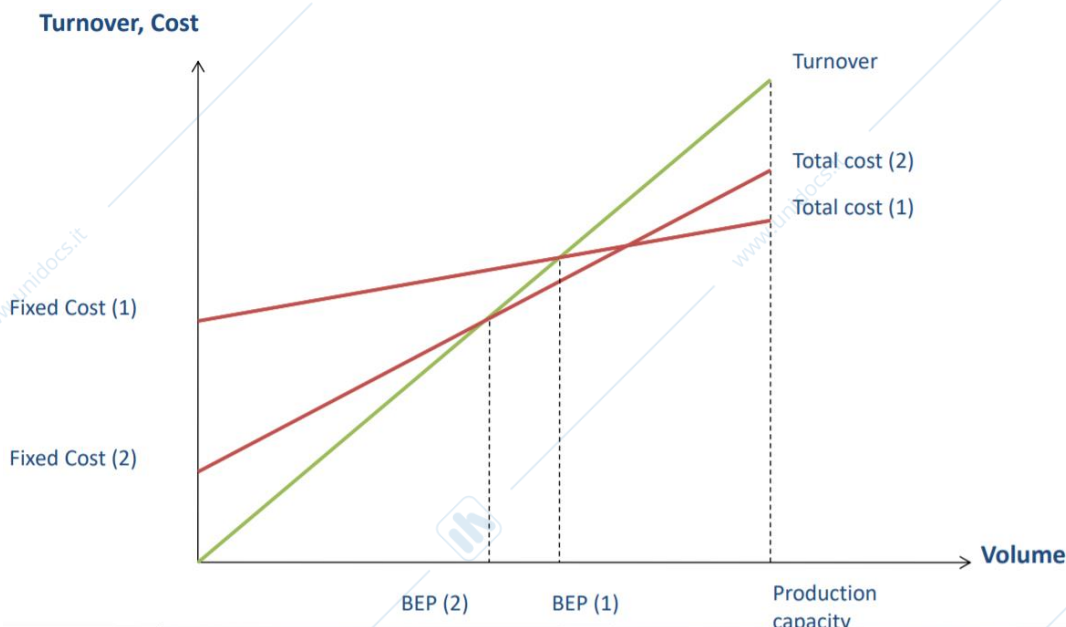
Do the conditions for an intermediate market exist? If a market does exist we have to ask ourselves if the strategic option for outsourcing exist and which are the relevant factors for the choice.

Market enablers:

- Costs and risks on the demand side: amount of information to exchange, asymmetry and opportunism, transaction costs for the customer.
- Costs and risks on the supply side: dedicated investments and sunk costs.
- Costs and risks on both sides: uncertainty as emerging markets, no established standards and volumes.

Strategic drivers

- Competencies
 - Key or core competencies: competitive advantage (you create it), differentiation.
 - Lateral competencies: useful to enter in the business. It is not linked to the competitive advantage.
 - Special competencies: necessary but available externally and no rule for the vertical integration.
- Cost:
 - Cost reduction: outsourcing and offshoring
 - Flexibility: turning fixed costs into variable costs. (breakeven theory).



We can see that from making to buy the fixed costs decrease, but at the same time increase the variable cost in fact the slope increases. More the breakeven point is on the left, lower is the risk.

- Capex : outsourcing allows to reduce required investments to perform a specific activity. Improvement of financial indicator, thanks to the asset's reduction.

$$ROA = \text{EBIT} / \text{Assets}$$

Outsourcing drawbacks

- Increased costs: Lead time in service from outsource provider due to distance can add substantially higher delivery and inventory costs, Rising wages, Excessive transition costs for provider training and Expenses of negotiating
- Loss of control: Dependence by the client on the outsource provider, Loss of flexibility in controlling business activities and final product by client managers and Loss of skills that might be needed in the future.
- Negative impact on customer and sustainability: Lead time in service from foreign outsource provider may delay delivery and increase costs to the client firm's customers, Fossil fuels and pollutants due to transportation
- Difficulties in managing relationship: Communication and cultural barriers, Excessive investment of time in building a relationship with the outsource provider, Design changes in products can be difficult far away and Outsource provider may be unable to communicate difficulties and opportunities.
- Increase risks: Risk of the outsourcing project implementation, Risk in selecting the "right" provider, Risk of global outsourcing, Security risk issues and information confidentiality.

Purchasing organization

The role of ICT: ITC increases market transparency, reduce communication costs and integrate information systems.

- eSourcing: market efficiency. Increasing market efficiency by demand/supply matching.
- eProcurement: procurement process efficiency. Increasing procurement process efficiency by streamlining and automating purchasing procedures.
- eSupply chain: execution and collaboration. Execution means automating direct materials procurement flow while collaboration means increasing collaboration between customer and supplier.

Procurement 4.0 stands for the ultimate digitalization and automation of the function within its company and supplier environment, but it is not limited to the use of new or enhanced technology systems.

Challenges for purchasing:

1. Strategic sourcing: focus on strategic rather than tactical supply chain
2. Sourcing: manage strategic relationships with suppliers
3. Supply: integrate and exploit supply base technologies and capabilities
4. E-procurement deployment: it frees the purchasing debt from operational activities and gives economic benefits in terms of sales, costs and assets. It is not a local phenomenon but a global one. 2 areas:
 - strategic tasks: low frequency and high impact (as buying a new house)
 - operating tasks: high frequency and medium impact: (as buying a cheese burger).

Supply chain finance

Supply Chain Finance (SCF) means increasing efficiency and effectiveness of inter-company financial flows by implementing innovative solutions that exploit the knowledge of dynamics and relationships in the supply chain, adopting a broader perspective. Innovative solutions are enabled by advanced information technologies that connect companies and reduce the cost of managing the flows. By exploiting the knowledge and the information embedded in the supply chain, it is possible to better assess the risk at a lower cost.

- Financial provider: banks
- Information provider: provider of trust and transparency.
- Insurance: to protect our credit
- Technology provider: data sources

Working capital = operative wc = net operative wc = inventory + account receivable – account payable

Cash to cash (C2C) = Days inventory holding (DIH) + Days sales outstanding (DSO) – days payables outstanding (DPO)

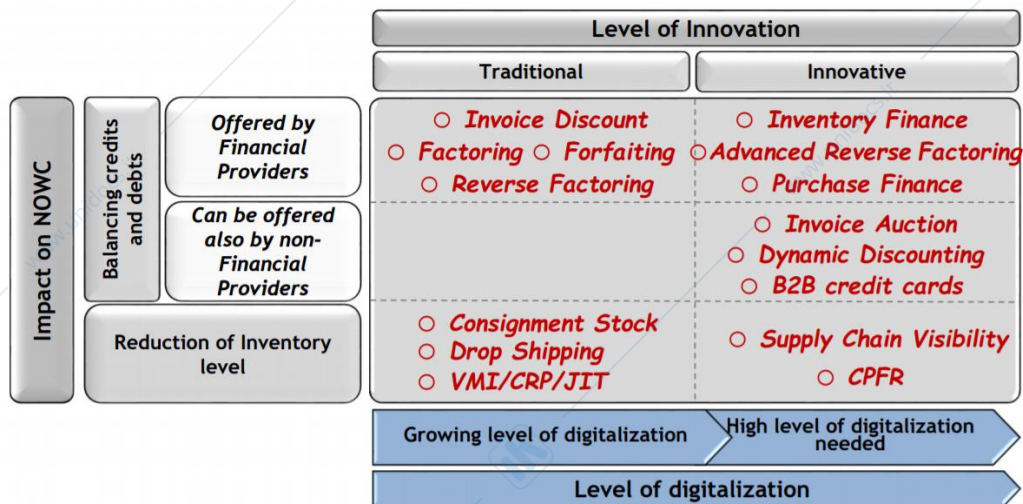
- C2C: average lead time between suppliers payment and customers payment. If C2C<0 it means that customers are willing to pay in advance.
- DIH: manufacturing lead time
- DSO: days to receive payment
- DPO: days to pay. High DPO for customers means high DSO for supplier, who are often smaller companies, therefore creating negative chain effect upstream.

Supply chain implications

The weakness of an actor in the supply chain becomes a potential source of risk for all the others, including the most robust, because they may lose valuable partners, hardly replaceable.

Companies cease their activities even if they have orders to be fulfilled, because they don't have the liquidity needed to work. Degenerate phenomenon which triggers, through a domino effect, unforeseeable consequences and problems even on solid suppliers and customers, who suddenly find themselves without a business partner.

Classification of supply chain finance solutions (important)



Invoice discount

- The supplier delivers goods to the customer and issues an invoice
- The supplier shows the invoice to the bank as a collateral in order to receive short-term financing (advance payment)
- The bank charges an interest rate proportional to the credit risk of the supplier
- Once the customer has paid the supplier, the supplier pays back the bank
- The bank has no relationship with the customer, the credit risk is assessed considering only the supplier characteristics
- This service is usually expensive for the supplier, since the default risk is not mitigated

Factoring

Factoring means selling accounts receivable to a finance company.

Factoring can be with or without recourse:

- With recourse, if the customer doesn't pay the bills within the agreed time, the factor collects them from the supplier company (prosolvendo)
- Without recourse, if the customer doesn't pay the bills, the factor will absorb the loss (prosoluto) – therefore it is more expensive

Most factoring is done with notification:

- The customer company is notified and instructed to pay its bill directly to the factor
- When factoring is without notification, the customer may send payment directly to the supplier, which in turn will reimburse the factor

Reverse factoring

- Reverse factoring is a financing solution initiated by the customer in order to help his suppliers to finance their receivables more easily and at a lower interest rate than what they would normally be offered.
- Unlike traditional factoring, where is the supplier who initiates the process, in this case the customer takes the initiative.
- Usually a large and solid customer, with a low credit risk (i.e. low cost of financing), agrees with a financial institution to offer the solution to its suppliers, who generally have a higher credit risk (i.e. higher cost of financing).
- The financial institutions agrees to finance the invoices approved by the customer considering the lower credit risk (the customer is the debtor).
- This is a real Supply Chain Finance solution, since it considers the characteristics of both customers and suppliers, and their relationships.
- Suppliers obtain advance payments at lower costs, Customers obtain payment term extension from suppliers, Financial institutions issue loans with lower risk and costs

The process:

1. The supplier transmits the invoice of the transaction through the IT platform;
2. The buyer receives it through the ERP system;
3. The IT platform informs the buyer about the invoice;
4. Once the buyer approves the invoice, the supplier receives the communication through the platform. The supplier may wait until the expiration of the payment terms (buyer's payment), or request a credit grant from the bank;
5. In the second scenario, the bank receives the request through the IT platform;
6. The bank pays the supplier for the invoices, withholding the agreed fees
7. Once the payment term will be expired, the buyer will pay directly to the bank. The financial risk of the bank is thus transferred from the relationship bank-supplier to one bank-buyer, as the approval of the invoice by the buyer forms the basis for bank's decision to grant a credit

Benefits

For buyer/customer	For supplier	For bank
Reduce the cost of goods purchased (lower price)	Reduce the cost of capital through improved DSO	Build stronger, collaborative relationships with customers
Reduce working capital through improved the DPO	Generate more flexible and predictable cash flow	Enhance customer retention
More stable supply base	Gain access to low-cost finance rates	Increase bottom line by supporting customers' entire supply chain from end to end
Improve relationships with suppliers	Acquire more secure source of working capital	Increase reach of trade finance organization
Improve visibility across the financial supply chain	Gain visibility into the payment process	Expand profile of trade finance organization

Factoring vs reverse factoring

	Factoring	Reverse factoring
Covered value	70-85%	100%
Commercial risk	Recourse/non recourse	Non recourse
Point of start	Supplier	Buyer/customer
Payout	Factors may anticipate or pay at maturity	Factors pay out immediately the suppliers
Services	Factors owns the entire credit collection process and may offer also others services	Automated platform facilitates both approval and funding process
Final fee	Depending on supplier rating	Depending on customer rating

Digital reverse factoring

- Invoices are exchanged electronically between suppliers and customer, through an IT platform
- Customer approves invoices on the same platform
- Suppliers decide to discount the invoices on the same platform
- The Factor is connected to the platform and provides the service at pre-negotiated conditions

Forfaiting

- Used in the case of export of high value goods with long payment terms
- The customer's foreign bank issues a letter of credit/letter of guarantee to the supplier's local bank
- The supplier receives a discounted advance payment by its local bank in exchange for the invoice
- The local bank is guaranteed by the foreign bank
- The customer pays at maturity through the foreign bank

Inventory finance

- The financial institution finances the inventory to reduce the NOWC in the supply chain.
- The inventory serves as collateral, a third party (e.g. logistic service provider) may be involved
- The risk of insolvency is managed by selecting solid and continuative relationships

Advanced reverse factoring

- Digital Reverse Factoring with richer information sharing, including Vendor Rating
- The customer provides the Factor with valuable information on the suppliers performance, to allow a better risk assessment

Purchase finance

- In industries with very long production cycles, suppliers need financing before delivering the goods (e.g. before invoicing)
- Customers agree with financial institutions to provide early financing to suppliers using e.g. purchase orders as collateral
- The amount of financing is generally only a portion of the value of the order
- The risk is higher compared to other solutions

Technology provider – platform provider

- Closed: just one bank and one customer
- Open finance: several financial institutions are involved with one customer
- Double open: several customers can upload their invoices and bank can compete to finance them. It represents the highest opportunity for supplier and customer but it is risky.

Supply Chain Finance Costs

- Financial fee for the credit management service
- Investigation expenses
- Fixed payment for each invoice transfer
- Expenses for credit account management
- Exchange rate risk coverage

Supply chain finance benefits

- Financial benefits related to the Net Working Capital reduction
- Lower trade receivables and inventories, higher trade payables
- Efficiency in the supply chain processes and in the relationships with financial actors
- Lower administrative costs, higher speed
- Economic benefits related to Profit improvement
- Higher sales, lower material and financial costs
- Strategic benefits by supporting supply chain partners
- Protect critical resources
- New business opportunities for those working in the financial industry
- A large market, with interesting risk/return ratios

Blockchain

Blockchain is an encrypted digital ledger. Blockchains are about organizing consensus on the contents of a shared ledger in a decentralized and distributed manner.

Every node in the blockchain owns a copy of the digital ledger. Every transaction is recorded in all copies on the base of a consensus mechanism. No central authority exists and no single node can modify a transaction without consensus. Every transaction is encrypted and digitally signed.

Supply chain risk management

Supply chain risk is a risk coming from outside our company and typically is coming from downstream which means customers, or upstream, that means supplier. Usually we are talking about upstream that is called business risk. In general when talking about risk we talk about unexpected events. We need to cover the damage. Unexpected means probability. You have to take into account the unexpected even and the appropriate solution for the problem or the damage. The damage is the impact that is called **magnitude**. Probability is a very sophisticated concepts, hard to handle in practice. We can use the **frequency** to measure the probability. Frequency is clear and is based on experience. The higher is the frequency, higher is the experience that means knowledge.

Risk = magnitude x frequency

In this way we can represent a set of curves corresponding to different level of risks. This is an alternative way to represent a matrix risk. How we can reduce the risk level?

- Reducing the frequency = preservation strategies
- Reducing the magnitude = protection strategies
- Mitigation = reducing both frequency and magnitude
- Recurrent risk: refer to fluctuation in demand, supply, quality which occur in a continuous manner in a reasonably well defined range. Having an high frequency and a low magnitude is easier to manage; this is the typical area of insurance against a very well known damage.
- Disruptive risk: refer to events whose probability is very hard to estimate. Having an high magnitude and a low frequency is a trouble because here the event is likely to create a big disruptive risks, here the frequency is very low so we have no knowledge about it and this situation is the area of business continuity plan.

Risk management in general is described as the identification and analysis of risks as well as their control.

A main particularity of Supply Chain Risk Management (SCRM), is that it is characterized by a cross-company orientation aiming at the identification, reduction and control of risks not only on the company level, but rather focusing on entire supply chains.

Types of supply chain risk

- Random: natural phenomena
- Accidents: unintentional, cause bay negligence
- Intentional: caused by intentional action as strike or terrorism.

The main supply chin risk sources are on the upstream as the raw material price fluctuation, currency fluctuation and market changes. The speculative stock protects against the lack of raw material.

The four basic constructs

1. Risk sources: the environmental, organizational or supply chain-related variables which cannot be predicted with certainty and which impact on the supply chain outcome variables:
 - Environmental risk sources comprise any uncertainties arising from the supply chain environment interaction
 - Organizational risk sources lie within the boundaries of the supply chain partners
 - Network risk sources arise from the interaction between the organizations along the chain
2. Supply chain risk consequences: supply chain outcome variables affected by risks sources becoming events
3. Supply chain risk drivers: factors exacerbating the risk exposure as well as the impact of any supply chain disruption.
 - Focus on efficiency rather than effectiveness
 - Reduction of supplier base
 - Centralized distribution
 - Focused factories
4. Supply chain risk mitigating strategies: the moves organizations deliberately undertake to mitigate the uncertainties identified from the various risk sources. there are 2 types of strategies for reducing supply chain risks. The first type is intended to reduce the likelihood of the occurrence of certain undesirable events, while the second type is designed to reduce the negative implications of these events.
 - Acting on occurrence (likelihood)
 - Acting on severity (consequences)

Risk consequences

Risk consequences are the focused supply chain outcome variables concerning a range from commercial and financial performance (e.g. costs or quality, stock-outs or high level of inventory).

The anatomy of a disruption – resilience

To talk about resilience we have to study the anatomy of disruption. We need to introduce a diagram where on the x axes you find time while on the y axes you find the performance. The idea of performance is the productivity. Supposed that here the higher performance is the better. The initial level remains the same also during the preparation time. (before a disruption there is a preparation time). Then a disruption takes form. When the disruption happens, apparently we have no effect because we have safety stock or speculative stock. But then we can see an initial loss of performance that is well known as initial impact. Then there is a dramatic loss of performance in very short time. Here you realize that if you don't do nothing you will be not the same. Here you have to take a decision to take actions to reduce the effect. But for a given amount of time the loss of performance is limited but you are still taking the decision, this time is called the preparation for recover, where recover stands for recover performance. Then we can see an increasing but we can have 3 different situations:

- Worst than before
- Equal to before
- Better than before

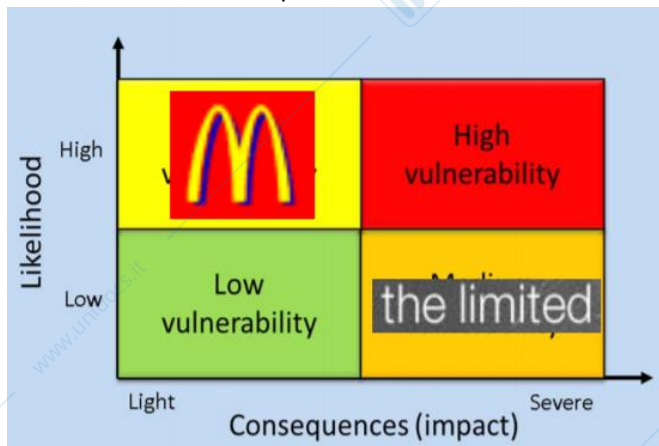
Now we can talk about resilience. Higher is the resilience, the lower is the impact of disruption. The lower the time to full recover is, higher is the resilience. When we talk about resilience we are talking about our ability to recover from the disruption. Resilience is the ability of companies or supply chain to minimize damage after disruption and the time for return to the original situation. The higher the resilience, smaller is the area.

Likelihood and consequences of risk source

- **Likelihood:** It is the probability that a risk source actually happens. It can be estimated on the basis of historical data
- **Consequences:** Related to the impact of the disruption in terms of: Financial consequences, Environmental consequences, Health and safety consequences

Vulnerability

An enterprise vulnerability map categorizes the relative likelihood of potential risk sources and the relative resilience to such disruptions.



higher the resilience, lower the vulnerability.

- **Moderate vulnerability:** Frequent monitoring to assure its significance has not changed due to changing business conditions.
- **High vulnerability:** Prevent at source. High priority risk sources. They must be avoided or prevented by means of continuous actions.
- **Low vulnerability:** Low control: Minimum monitoring is needed. The monitoring frequency increases if a trend towards other quadrants is detected.
- **Medium vulnerability:** Detect and monitor. Need to be monitored on a rotational basis. Detective control to ensure that these high significance risks will be detected before they occur.

The main ways in which companies are coping with supply chain risk

- Create and implement a business continuity plan
- Implement dual sourcing strategy
- Use both regional and global strategy

Redundancy

Keeping some resources in reserve to be used in case of a disruption: Additional stock, Additional capacity, Additional suppliers, Knowledge and process backup.

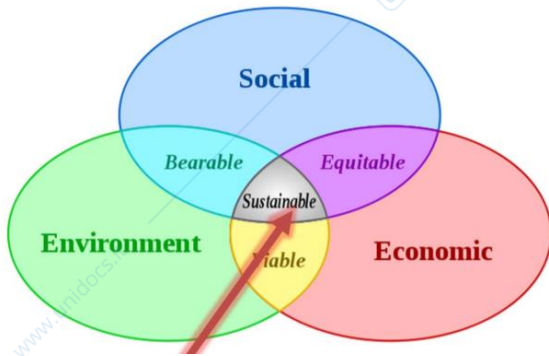
Sustainable supply chain management

The goal of sustainability is to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.

Snowball effect: an effect is going to grow in the time. When a negligible effect become a dangerous effect for our company.

The triple bottom line

The management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, ie., economic, environmental and social, into account which are derived from customer and stakeholder requirements



Economic: economic performance, market presence, indirect economic impacts.

Environmental: materials, energy, emission, transports..

Social: labor, human rights, society, product responsibility..

Companies are looking at their supply chain to enhance their overall sustainability profile for two reasons:

- focal companies are responsible for environmental and social problem caused by their supplier
- increasing share of value is created at the supplier level

The greatest benefits are derived by extending the focus as far as possible:

- upstream, towards the raw materials
- downstream, towards the consumer
- back again as the product and wastes are recycled

Sustainable supply chain: The implementation of a sustainable supply chain means:

1. Improving the performance of the business' own operations
2. Working with suppliers to increase efficiency and competitiveness
3. Ensuring that goods and services provided by suppliers are sustainable
4. Working effectively with customers and sales channels to design sustainable products and services

Divers and barriers for sustainable supply chain management

Ranking	Driver	Barriers
high	Top management initiatives	Initial buyer and supplier investment
	<u>Compliance with law and regulation</u>	<u>Economic uncertainty</u>
Medium	<u>Competitive differentiation</u>	Short vs long term goals
	<u>Cost savings</u>	Lack of regulations
	<u>Customers' requirements</u>	Little top management support
Low	Governments incentives	Suppliers lack resources

Sustainability for business: framework

	Short term	Long term
Specific to a company	Good business practices: transparency and supply chain productivity	Competitive differentiation: product redesign, new market entry, new organizational models
Shared universally among all companies	Table stakes: public relation, compliance and efficiencies	Game-changing innovation for the future: reframed economic models, partnership with stakeholders

Sustainable supply chain practice with suppliers

How to extend sustainability to suppliers? Two main types of mechanisms:

- Suppliers' assessment: questionnaires, company visits at the supplier's site, development of code of conducts to be signed by suppliers
 - Collaboration with suppliers: working directly with suppliers providing them with training, support
-
- buying from SMEs and local suppliers helps regeneration of the local economy
 - choosing socially responsible suppliers that support communities helps employment and social conditions.
 - buying from minority-owned SMEs and social enterprises, organizations can support disadvantaged sections of society.
 - choosing ethical suppliers helps acceptable labor practices in developing countries
 - environmental criteria in contracts helps the provision of environmentally friendly products and a reduction in packaging.

Design rules for sustainability

- Reduce raw material consumption and increase the percentage of recyclable content
- Non-polluting production and non-toxic components
- Don't cause negative impact or damage to species, most of all the endangered ones
- Low consumption of water and energy during sourcing, production, distribution, use and disposition
- Minimal or non-existent package
- Possibility of reuse or recycle (up-cycle)
- Longer usage period, allowing updating rather than substitution
- Possibility of collection and/or disassembly after use
- Possibility of remanufacture or re-use

Measuring sustainability in the supply chain

Social issues

- protection from harm
- development of human potential

Environmental issues

- reducing the negative impact on the nature
- improving the state of nature