Ekonomická fakulta
Faculty of Economics
Jihočeská univerzita v Českých Budějovicích
University of South Bohemia in České Budějovice

Supply chain management

Drahoš Vaněček

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Akehurst-Moore Gregory Thomas, B.A.: Chapter 1–6
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ISBN 978-80-7394-631-9

Obsah

Introduction

The electronic textbook “Supply Chain Management” is intended for magister study “Management and Economy” at the South Bohemia University, Faculty of economics in České Budějovice.

The textbook is oriented first of all on methods of the Supply Chain research with the aim to maximally satisfy the customer. It contains some practical examples and analyses new issues which must logistics to solve in our time: reverse logistics, waste management, impacts of production on the environment. Sources of risk and risk management form the last chapter.

The author welcomes all comments which will help to improve teaching of the subject Supply chain management.

prof. Ing. Drahoš Vaněček, CSc.

1 Supply chain and Globalization

Chapter objectives

- The terms Logistics chain and Supply chain are equivalent in meaning.
- Formerly, Logistics was connected only with selected parts of a firm's activities. Today it focuses on the whole Supply chain, mostly because of intensive globalization and specialization. That is also the reason why our study subject concerns the whole Supply chain and its management.
- Firms entering into the global environment can have different forms, and structures. A firm can do global business by itself or use intermediaries.
- International business does not increase transport costs too much; economy of scales is used here and also improvements in transport and communication technologies help to overcome long distances.

1.1 Globalization and its development in different countries

Globalization expresses the world's level of organization and integration and covers regional, national and local systems in the real world.

Earlier term: **internationalization** – represented production in one country only, distribution and selling in the whole world.

Globalization – represents production in different areas of the world, and selling products also in the whole world. Information and communications technologies created the basis for globalization.

Unequal development
Different countries have different courses of development due to their history. Globalization makes their economic development much faster. It depends how these countries will be engaged and integrated into the system of the global economy.

Globalization divides different countries into similar groups according to their economy. A new international division of labour appears here.

- Countries of the world's periphery – production of components or simple products only.
- Countries of the world's semiperiphery – assembling or production of components. Traditional products are produced only.
- Core countries, with a mature economy. They develop new products, technologies, ideas. More value added in products.

Unequal development.
US firms expanded in the 1960s to Europe.

Japanese firms expanded to the whole world in the 1970s and liquidated many traditional branches.

Today – we can see, how much China is expanding.
But there are also other countries with higher economic development.

Some impacts of globalization

(a) Positive consequences

- Extent of new technologies (communication, transport, information...).
- Increase of production in less developed countries (India, China...).
- Increase in the standard of living of residents in less developed countries.
- The possibility of prompt contact with enterprises around the world.
- Global cultural changes also in traditional conservative societies (Islamic) – internet, clothing, habits…

(b) Negative consequences

- Damage of environment in less developed countries.
- Extent of English language in the world as a fundamental, basic language.
- Extent of uniform culture.
- Erasing of culture differences among nations.
- Expansion of terrorism and global illnesses.
- Unrest between immigrants and residents.
- Easy access to weapons and expansion of terrorism.

Enterprises have to accommodate to new situations, generated by globalization. There does not exist a uniform model of a Supply chain. So every organization must construct its own or integrate into an existing one.

In the next text – some possibilities of how to penetrate into international markets are shown.

COMPANIES IN THE GLOBAL ENVIRONMENT:

1. National companies – they work only within their home market.
2. International companies – they have facilities in different countries, but these are centred in one home country. Subsidiaries are in other areas. The headquarters control the activities of all subsidiaries.
3. Multinational companies – they form a more loosely linked, largely independent set of companies working in different geographical regions. There is no rigid control from central headquarters. The separate divisions have more flexibility to adjust products to local needs.
4. Global companies see the world as a single market. They make standard products for shipment anywhere in the world, using a location where they can work most effectively and efficiently. They coordinate all their activities as if they supply a single market. (Coca-Cola makes the same products around the world with all operations coordinated to meet demand as efficiently as possible.)

This description may be misleading as it suggests that organisations (firms) choose a single best organisation and use it for all their operations. In reality, firms have to be flexible. For example, a company might work globally in Europe and multi-nationally (internationally) in Africa.

Table 1.1 Some features of global operations

Domestic/export		**International/multinational**	**Global**
Product	Variations on domestic product	Tailored to local markets	Single product in all markets
Product range	Fairly narrow to meet domestic needs	Wide to meet different needs	Narrow
Marketing to	Specific customers	National markets	All regions
Operating costs	High	Medium	Low
Logistics providers	Third party and intermediaries	Subordinate firms	Appropriate parts of the organisation
Management	Centralized	Diverse	Coordinated
Information	Based on home country	Diverse	Integrated

1.2 Supply chain and logistics

Definition of logistics – at the present time, logistics is shifting from engagement in one organisation to complex Supply chain problems.

Formerly Logistics: delivered necessary goods to the demanded place in an acceptable quality, time and acceptable price. This does not apply anymore, because: What is acceptable? And for whom is it acceptable? It is not possible to concentrate only on your own enterprise, but also on the suppliers and clients.

Today's Logistics: planning and managing the whole logistics chain (Supply chain, SC) with the aim to maximally satisfy the customer. Logistics becomes a strategic factor of enterprise development.

Reasons for a new definition of logistics – the consequences with its gradual development:

- Using logistics in the framework of the whole SC.
- Transition from traditional (functional) to process management.
- Accent on satisfying the end customer, not only the producer.
- Necessity to integrate logistics into strategic plans of an enterprise.

Historical development of logistics towards Supply chains (the borders of time periods are not exact):

(a) Only physical distribution – deliveries to shops, solving transportation and storage problems only (at about 1970).

(b) Applying Logistics to the purchasing process and management of production (production's planning, MRP – 1970–1980).

(c) Integration of individual and independent links (nodes) into the Supply chain (suppliers, customers etc.). Forming of logistics departments.

Influence of globalization. Customer is considered as a part of the SC – (2000).

(d) Optimization of the SC. New communication and information technologies. EDI, Strategic alliances.

Barriers: Fear of sharing information and its misuse.

(e) Logistics implies also reverse flows – Reverse logistics – after 2000.

(f) Green logistics – considering the impact on environment.

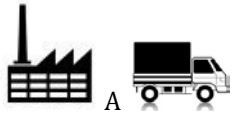
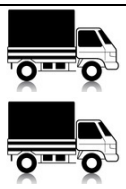
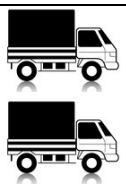
1.3 Models of supply chains in globalization

Table 1.2 Ways of Reaching Foreign Markets

	Home country	Abroad	
	Production	**Production**	**Distribution**
1	Home (Firm A)	0	Own-original producer (Firm A)
2	Home (A)	0	Local firm (B)
3	0	Own (A), expanding abroad	Own (A)
4	Production of parts only (A)	Local firm assembly (B)	Local firm (B)
5	Home firm (A) + Local firm from abroad (B) = Joint Venture (C), production abroad		
		Local production (C)	Local distribution (C)
6	Licensing or Franchising	Local production (B)	Local distribution (B)

1. Home production and own distribution network abroad
Products are manufactured at home and exported to meet local demand. The manufacturer increases his control of the supply chain by replacing the local distribution company with its own subsidiary. The manufacturer runs the production and distribution himself. Disadvantage: more knowledge of local conditions is needed.

Figure 1.1

HOME COUNTRY	ABROAD		
PRODUCTION	PRODUCTION	DISTRIBUTION	CUSTOMERS
1.  A			CLIENTS
2.  A		 B_1 B_2	CLIENTS
3.[ ]A no production	 A_1 **Expansion**	 A_1 A_2	CLIENTS
4.  A **Only parts**	 B **Assembly of parts**	 B_1 B_2	CLIENTS
5.  A	 B **A+B (Joint ventures)**	 C	CLIENTS
6.[ ]A no production	 B **Licensing, Franchising (know-how)**	 B_1 B_2	CLIENTS

Own source

2. Home production, distribution by local distributors.
For local distribution expert intermediaries are used who handle the trading and import arrangements. As there is no local manufacturing, the domestic company needs less investment and the exporter can achieve economies of scale.

On the other hand, exports do not contribute much to the local economy, so governments often add tariffs, import quotas or some other constraints. The success of a product also depends on the skill of export intermediaries, over which neither the manufacturer not the domestic company have much control. So a manufacturer runs the risk of increasing production to satisfy demand that largely depends on the success of other organisations.

3. Own production abroad and distribution by local distributors (Full local production and distribution).

The manufacturer opens full production facilities within the new market, to make and distribute its own products. This can be very expensive and time consuming. A faster way of getting significant participation is to buy a company that is already working locally. If a firm already works successfully in a market, a larger company can buy it, inject cash and utilize it. This is how foreign food supply chains work when expanding into other countries.

The essential feature of own local production is that the manufacturer retains control over all operations and reduces transport and operating costs. Disadvantage: more knowledge of local conditions is needed.

4. Exporting parts and using local assembly and finishing of products.

This runs already into the area of partnership, where the manufacturer develops a closer supplier-customer relationship with a local assembler. Exporting only parts needs more local knowledge and skills, and the manufacturer loses control over key assembly operations, which depend on the local assembler. A part of value added is created in a foreign country, but the majority of components are supplied from the key production centre. Local firms abroad can use with advantage local know-how to organize distribution to end customers.

5. JOINT VENTURE

A Joint Venture is a business entity created by two or more parties, generally characterized by shared ownership, shared returns and risks and shared governance. A Joint Venture works so that usually the domestic firm together with another firm or organisation abroad establish a new common business-legal entity (usually a stock company). The aim is to join the advantages or experience of both partners together. For example, the company abroad can offer money or a brand, the domestic partner knows better the domestic market (Example: Japanese-Swedish Ericson).

A company typically pursues joint ventures for one of four reasons:

1. to access a new market,
2. to gain scale efficiencies by combining assets and operations,
3. to share risk,
4. to access skills and capabilities.

6. Licensing or franchising
Franchising is the practice of the right to use a firm's business model and brand for a prescribed period of time. The manufacturer (A) passes all operations to a local company (B) and allows it to make equivalent products. In return for a fee the original manufacturer (A) allows the local company to use its process, design, operations, trademarks, brands, knowledge or other skills. The licensee is responsible for operations in the new market, and the manufacturer retains some control through negotiated conditions for quality, testing materials, sales and so on.
Advantage: needing little capital, having low risk, using licensee's knowledge of local conditions, using existing facilities and skills, avoiding local import tariffs.
Disadvantage: lack of manufacturer's control over products sold in its name, development of a potential competitor.

Questions

1. Explain the term "globalization".
2. Does globalization bring the same advantages to all countries?
3. Explain some good and bad impacts of globalization.
4. Explain some possibilities for the firm to penetrate into a foreign country with its products.
5. Explain the form of franchising in an example (McDonald's).

2 Structure of the supply chain

Chapter objectives

- The structure of the Supply chain is formed by means of its links and elements (passive or active elements), which create different combinations.
- A Key link can be both production and a big retailer.
- Apart from open chains, more emphasis is now given to closed chains (reverse logistics).
- Logistics in the Supply chain creates value added for customers as value added of place, time and often of the form too.
- Logistics activities can be managed in many different ways (by different departments).

2.1 Logistics activities

Logistics activities are only NON-TECHNOLOGICAL operations (materials handling, storing, control, planning). They usually do not create value added of form, or only rarely, (usually only value added of place and time), but these logistic operations are necessary.

Other operations in manufacturing which are not a part of logistics:
TECHNOLOGICAL OPERATIONS: (cutting, painting, assembling...). They create the prevailing part of value added for the customer.

USELESS, or WASTED OPERATIONS – these do not create value added, they are not necessary, they only increase costs and must be eliminated from the Supply chain.

2.2 Logistics (supply) chain

Logistics (Supply) Chain
Logistics chain, or Supply chain is a set of physical (tangible) and intangible flows running in a series of subsequent (delivery and purchasing) links – subsystems, whose structure and behaviour is derived from demand: flexibly and economically satisfying given demand of the end link, customer (Pernica, 1998).

Which term should we prefer, Logistic chain or Supply chain? Currently the term Supply chain prevails, but the meaning is the same. The Supply chain in the service sector: there is also the flow (less of material, but more often the flow of customers). Which flow starts as the first? Material? Financial? Information? – Always the information flow.

Structure of the Supply Chain
The Supply chain consists of links (nodes). We prefer the term "link". Links of the chain (enterprises or their workshops, suppliers, manufacturers, distributors) or parts of them: warehouses, stores, railway stations, ports, ships…
Each link consists of a group of active and passive elements, adjusted to perform similar operations.

Active elements
Technical devices for material handling, transport, packing, storing. They make possible the flow of passive elements.

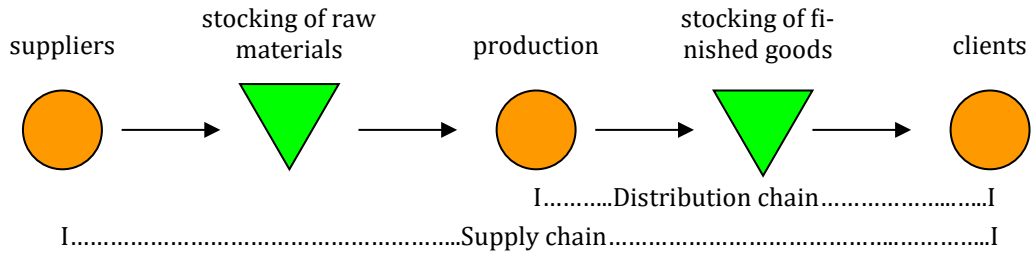
Passive elements
Raw materials, work-in-process parts and finished goods, packaging, waste, information. How did the material flow formerly (50–70 years ago), when we did not speak about Supply chains? Similar to now, but relations between links were not so close, were not dependent on long term contracts, and were without partnership relations, without sharing of information.

Supply chain
No enterprise can exist without cooperation with other enterprises, firms. When a firm buys material, it has the role of a customer, when it sells its products (finished or work-in-processed), it is a supplier. The Supply chain consists of many activities provided by organizations (firms or their parts only), which ensure the flow of material on its way from the supplier to the end customer.

Figure 2.1 Logistic chain (Supply chain) and its structure

Logistic chain = a complex movement of material and nonmaterial (information) parts between individual links of the chain.

Simple logistic chain



This figure is simplified. For bakers, mills deliver flour, mills receive grain from farmers, farmers buy seeds from specialized organizations etc. For this reason it is always necessary to define the parts of a Supply chain, which will be investigated. Every product has its own Supply chain and so chains of different lengths and forms have originated.

Figure 2.2 Model of a Supply chain in the food processing industry

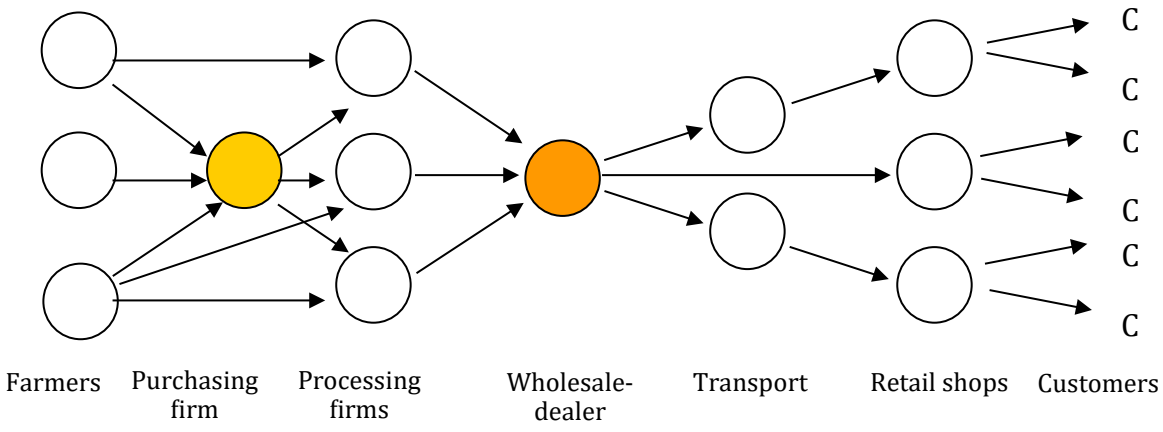


Figure 2.3 Basic structure of the Supply chain

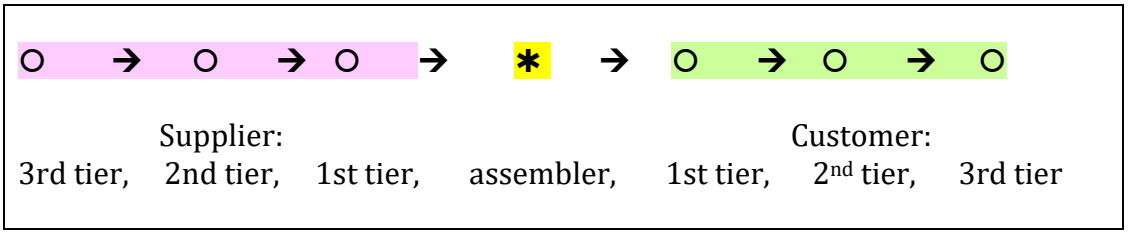
The simple Supply chain:

(The number of suppliers and customers is usually higher).

The simple Supply chain is depicted as a line of segments with one supplier only, one producer, one transport operator, one client, where the material flows from the supplier to other links and is transformed into finished product and delivered to the customer. This direction of flow is called "downstream". But information flows in both directions – downstream and upstream:

- From the client as an order to the producer.
- From the producer to the supplier of materials.
- From the producer to the client, so that his order is finished.

Figure 2.4 First tier suppliers and customers



When there are more suppliers which deliver necessary parts successively one to the other, so the supplier next to the manufacturer is called "the first tier supplier, the more distant supplier is the second tier supplier and the remote supplier of raw materials is the third tier supplier. Similar sequences can appear among customers.

Types of Supply chains

Short Supply chain

The short SC seems to be advantageous, but not in every situation. Example: if all residents of a city decided to purchase vegetables directly at the farm, then everybody should individually go to the farm and back. So it is better to deliver vegetables into a central market, near to the residents and so shorten the transport for everybody.

Long Supply Chain

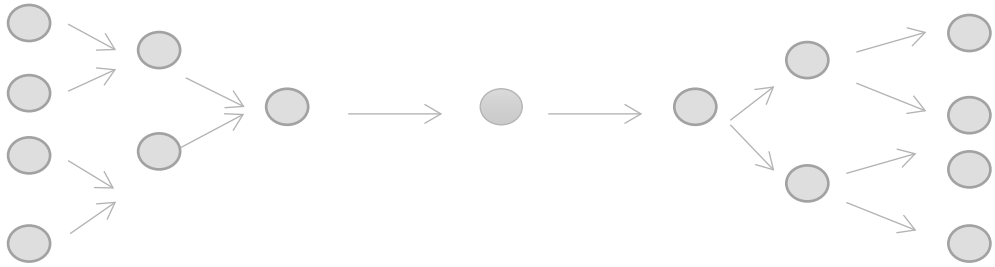
Such a chain has an advantage, when the activities of distant links are very cheap (links in Asia).

Simple Chain

Another view of a Supply chain: The Simple Chain (it has only the form of one line).

Figure 2.5 Composite chain

Composite Chain. It ramifies on its input and output



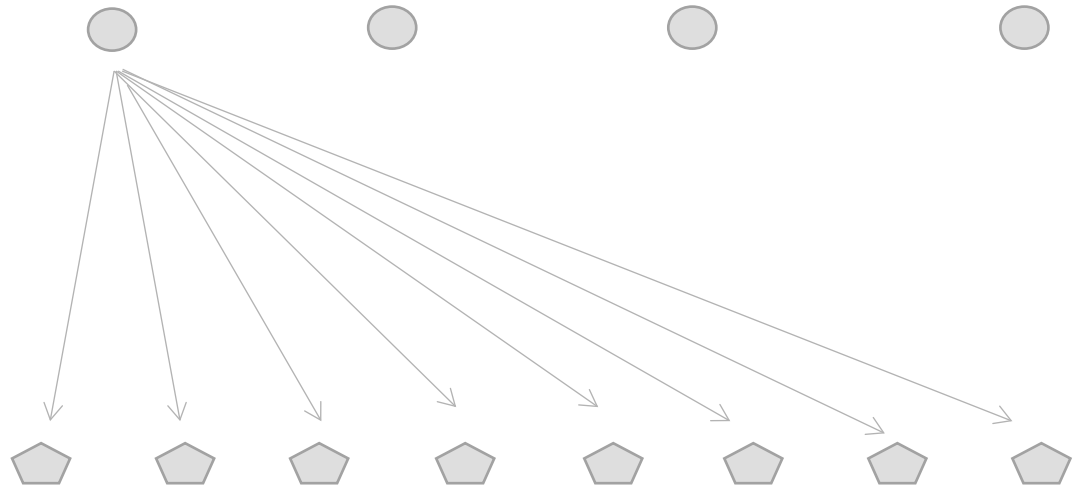
The extended chain, with more links, is not necessarily more complicated, sometimes, on the contrary, it is much simpler.

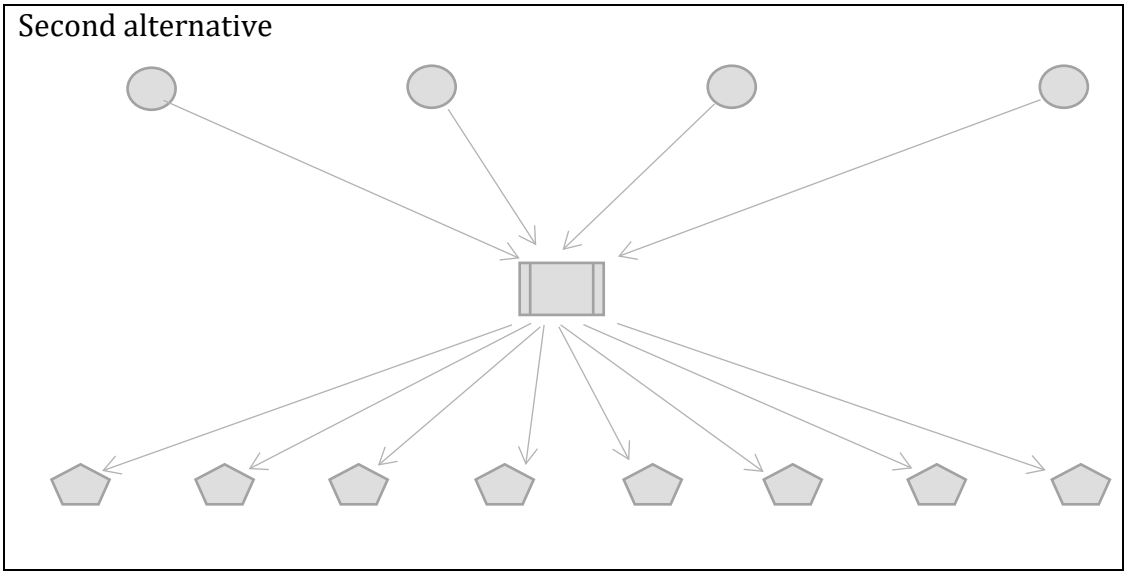
Let us consider 4 factories, each delivers its own goods to 8 customers. That makes altogether 32 routes.

When a new link to a wholesale store is established, only four routes will start from factories to the wholesale store and 8 from the wholesale store to customers, totalling 12 routes.

Figure 2.6 Intermediaries in the Supply chain

First alternative (repeated also at the next three links)





All chains mentioned here are open. In the last few years there has been an effort to lock, or enclose them by means of reverse logistics. The reason is the lack of raw materials and their constantly rising prices on one hand and ecological aspects – what happens to products after their life time, on the other hand.

Sometimes we meet with the term: delivery net. This is the same as the supply chain, only in another formulation.

Figure 2.7 Reverse chain

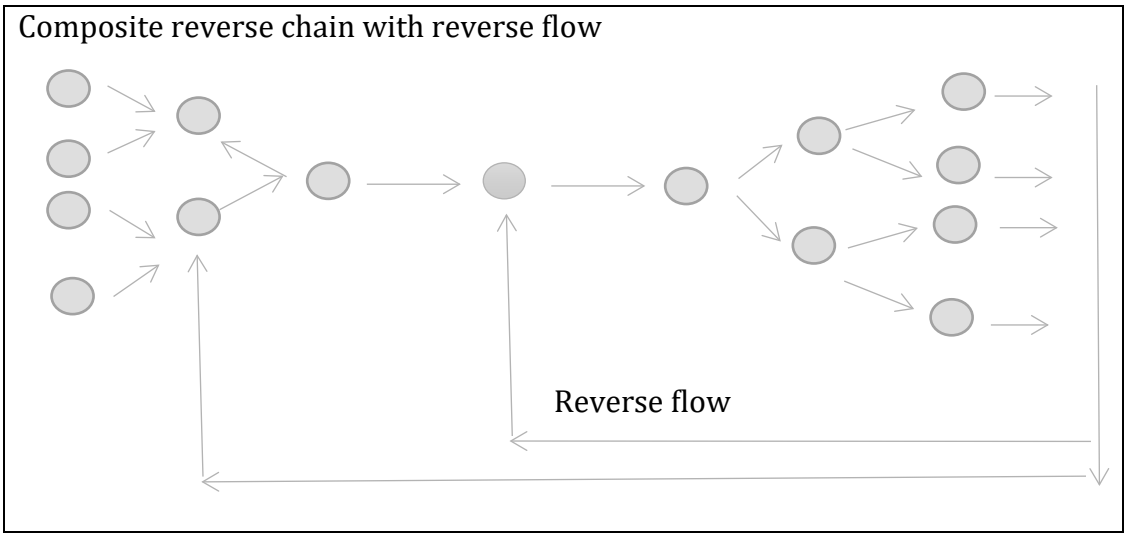


Figure 2.8 Possible SC in the chemical industry

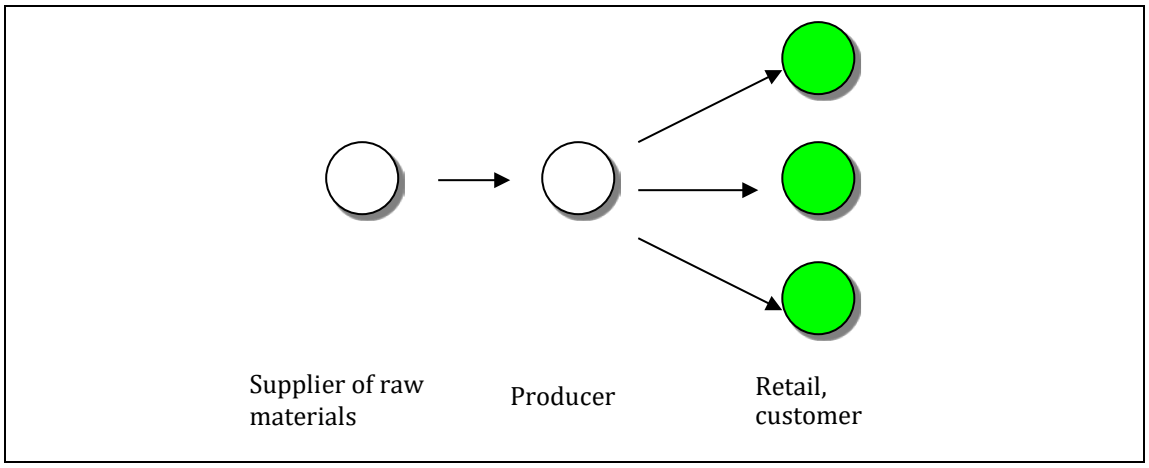


Figure 2.9 Diagram of developed SC in the engineering industry

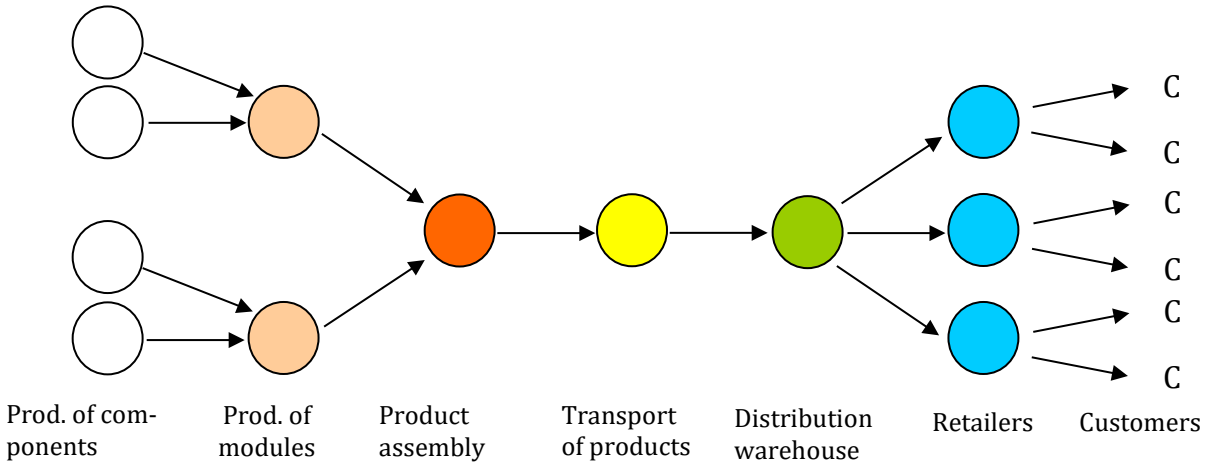


Figure 2.10 Diagram of the SC in the building industry

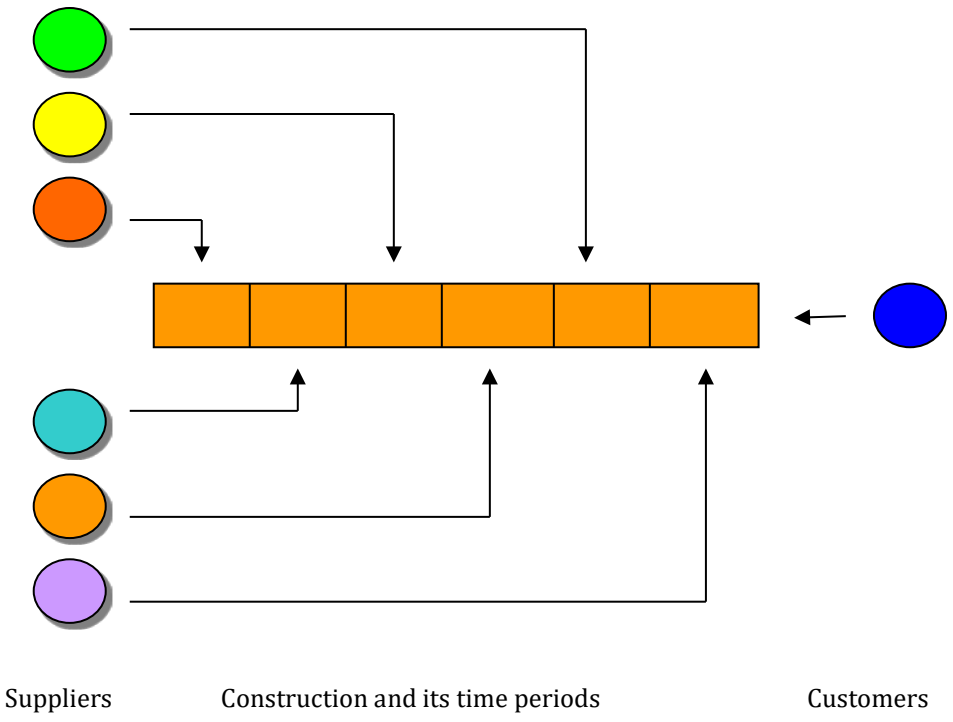
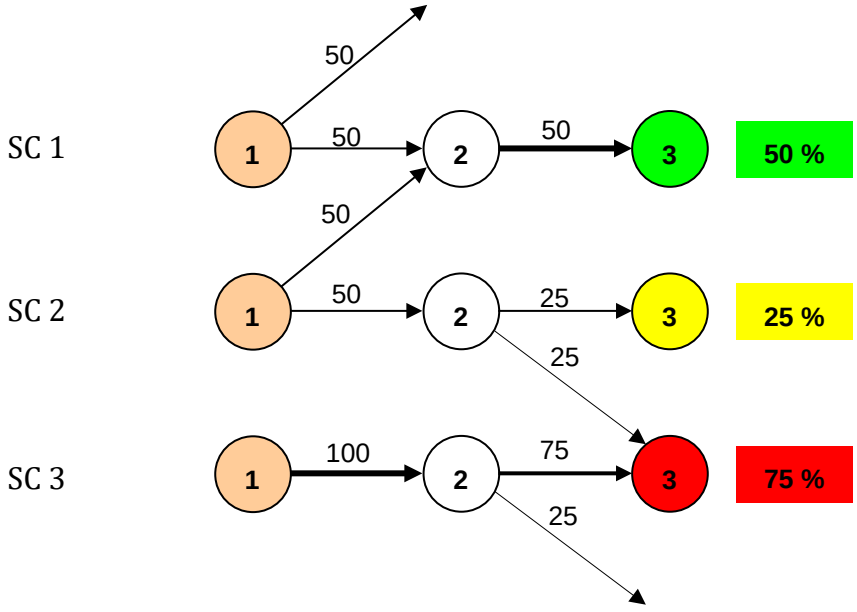


Figure 2.11 Alternatives on different material shares of the second and first tier suppliers on the final product (indicator of integration)



A higher percentage of deliveries creates the necessity of partnership.

There also exist chains of some big retailers (Tesco, Billa, Penny Market...). They usually have many integrated retail shops and one central warehouse. But their function is similar to those Supply chains described earlier.

2.3 Key link in the supply chain

The SC or a part of it must be in some way managed. This role applies to some of its links, usually the most important, which finish the product. There are two main possibilities:

1. Managing the SC when all links are owned by the key link (by one owner, or possessor only). Then it is probably much simpler to manage such a chain, but in real conditions such a chain can be cumbersome, when the links are too big and represent, for example individual enterprises.

2. Managing by the "convincing" method. The key link offers to the dependent link long term work, sometimes it can help with its know-how etc. That is very agreeable. But on the other hand the dependent link must try to decrease the costs every year for example by 2–3 percent. Such cooperation has advantages both for the key and dependent links.

In the car industry the typical key link is the assembly firm. But in other industries the situation can be different.

In the SC, there is usually the key link, which is represented by the assembly plant or the hypermarket. These key links manage the neighbouring links – they demand a certain volume of materials to be delivered in a demanded time or they send their products to the next links again according to given contracts. But there rarely occurs such a situation in which the key link manages the whole supply chain.

In a few cases, there exist chains where all links belong to one proprietor. Then this proprietor is able to manage the whole supply chain in the best way. (Example: Slaughterhouse chain, chapter 5). But it is rather ponderous to manage such a big complex. Formerly this existed at the Ford firm, where Ford owned the assembly line plant, steelworks, rubber processing plant, etc. But reaction to market fluctuation was not flexible.

More often we can meet situations where one proprietor owns two or three links in the chain. Example: a big retailer (Tesco, Kaufland etc.) has its own distribution warehouse, where all items are centralized. From here it delivers demanded goods to its own shops. From these shops the warehouse has perfect backward information about the last sales and so new goods can be delivered in time to replace sold goods.

It is also possible that in a longer supply chain there can be 2 or 3 key links. For example in the food processing industry one key link is the food processing plant and the second, the hypermarket, which influences necessary delivery of material or finished products.

The food production plant influences neighbouring farmers and their deliveries. The hypermarket then influences this food processing plant with its demanded assortments and quantities.

In long supply chains there always exist key links in Europe which manage production (assembly) and deliveries of material and parts and somewhere in Asia there must be again a key link which organizes the production of demanded parts and subassemblies and their consolidation and shipment to Europe.

How to find a key link?
The assembly plant for mass production, not only of cars, but also of other products, is a very expensive investment facility, which must be maximally used and exploited, to offer products at an acceptable price. For this reason it becomes the key element of the whole supply chain.

But is it the same situation in other branches than in the car industry? Does there exist also a plant (key element) that gives final form and image to the product as in the car industry and manages the suppliers and retailers? To answer this question, it is appropriate to select and compare some different products and formulate who is the end consumer of these products. Customers are usually considered as an overall group, but we must distinguish between customers of everyday goods and rich customers of luxurious goods. Distribution then can use the following channels: global (to all shops), selective (only to special shops) or exclusive (only some selected shops in a big area).

Table 2.1 Key link in different branches

Product	Production form	Product Life-time	Distri-bution	Invest-ments	customer	Number of producers	Key link
Motor car	mass	long	selective, exclusive	big	current + rich	small	P
TV sets, computers	mass	long	selective	big	current	small	P
Luxury watch	serial or piece	long	exclusive	middle	rich	small	P
Beer (Pilsen, Budvar)	mass	short	global	middle	current + rich	only one	P
Milk	mass	short	global	middle	current + rich	middle	R
Bread	mass	short	global	middle	current + rich	middle or big	R

Legend: P = production, R = Retail

Own source

The table shows that for certain goods the key element is at the end of the Supply chain (retailer), not the producer (for example the Supply chain of Tesco, Kaufland, etc.). These key links determine which goods they accept for sale, which amount the producer must pay for this possibility, which price they will pay to the producer, which discounts the producer may have to accept during different sales offers in the year etc.

These goods have a short turnover, they are assigned to everyday customers and available in a broad distribution net. The producer has not got its own system of retail shops and must accept this pressure. For foodstuffs (and also other goods of daily consumption) sold in business chains there is the key element "retail", which is the direct connection between the producer and current customer.

There are exceptions such as some traditional products with a well-established brand, for example "Pilsner beer" or "Budvar beer", in the Czech Republic. In one case a retailer cancelled the contract with the firm "Budvar" due to price and this beer was not sold. But customers demanded it and the retailer had to retreat. In such a case, the producer with a well-known brand is the key element of the chain.

Another situation concerns luxury goods. Theses goods are produced in small series, often only in limited numbers (fashionable goods). A producer usually sells their own goods and adjust them according to a customer's demands. These goods have prestigious importance for the customer. Their use counts the customer among successful businessmen, who are able to possess them. The key element here is a manufacturer with a well-known brand.

It is evident that the key element can be both the producer and retailer. There still exists another possibility: key element can be the marketing department.

One German firm sells shoes. It has only a small marketing centre without production and without retail. Business representatives monitor new trends in fashion shoes at different trade fairs and acceptable models produced in Asia, where a cheap labour force exists. After delivering demanded goods to the port in Hamburg, these are distributed to different warehouses in many European countries. This firm has no retail shops of its own.

Advantage: no production facility is needed; goods are produced cheaply in Asia.

Disadvantage: if the future demand was forecasted incorrectly, there is a loss. If demand is higher than forecasted, more of the fashion goods cannot be produced in time and delivered to Europe and there is a loss of possible benefit.

If demand is lower than goods ordered, unsold products stay in shops and must be sold at a reduced price with a loss of profit.

2.4 Corporate logistic strategy

Corporate logistics strategy
All activities in logistics (as also in other parts of the enterprise) must originate from the corporate strategy and from this top strategy, firms then derive their own logistics strategy. Corporate strategy represents:

1. Analysis of the enterprise environment, competitors, legislation, possible workforce.

2. Analysis of the current situation in the enterprise: products, services, cashflow, investigation, corporate culture. Corporate mission: why does the enterprise exist, on what products should it focus in business?

The aim:
Determine main tasks, roles for next 3–5 years.

Logistics management comes out of the corporate strategy
Logistics management deals with effective flow of raw materials, inventories in production and finished goods from the place of their origin to the place of consumption. How to find logistic activities? They are derived from:

(a) Corporate strategy.

(b) Material and information flow.

1. Logistic Activities Derived From Corporate Strategy

(a) Activities concerning development of the enterprise. Formulation of strategic tasks of logistics.

- Location [choice of the seat of the enterprise or its part].
- Choice and internal evaluation of suppliers.
- Demand forecast and logistics planning.
- Logistics audit and improvement of contemporary situation, etc.

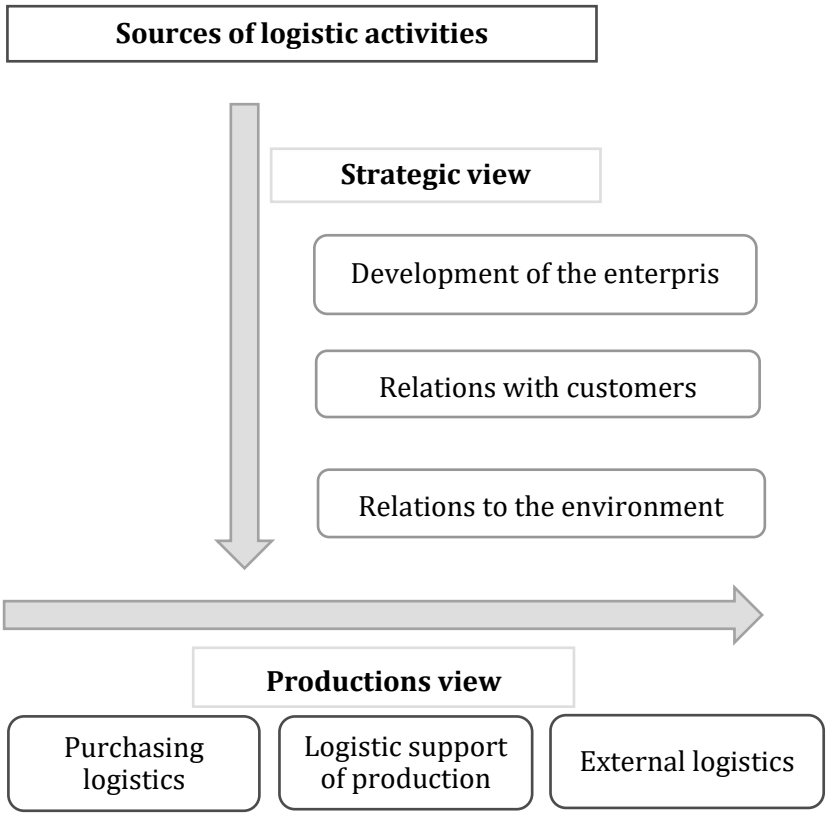
(b) Activities expressing relations with customers.

- Evaluation of logistics services provided to customers.
- Managing relations on the boundaries with other links of Supply Chain.

(c) Activities expressing relations to the environment.

- Strategy of waste management and recycling.
- Green logistics.

Figure 2.12 Sources of logistic activities



Own source

2. **Logistic activities derived from material and information flows**

   More logistic activities come from existing material and information flows and current operative activities. The main areas are: a] Logistics of procurement, b] Logistical support of production, c] Exterior logistics.

A] Logistics of procurement

- Material management [material ordering, storage, checking].
- Order receipt and tracing of its fulfilment.

B] Logistical support of production

- Interdepartmental transport.
- Logistical support of production [logistics planning], MRP.

C] External logistics

- Stocking of final products, their commissioning and expedition.
- External transport [to clients].
- Reverse logistics.
- Waste management.

2.5 Logistic system

The Logistic system and its structure consists of individual elements, which are its smallest units and are not broken into smaller details. One element can be considered as, for example, a warehouse, a production hall, a transport department or in a more detailed investigation, a fork-lift truck with its operator, machines and workers in production or in transport. It depends to which level of detail we wish to investigate it.

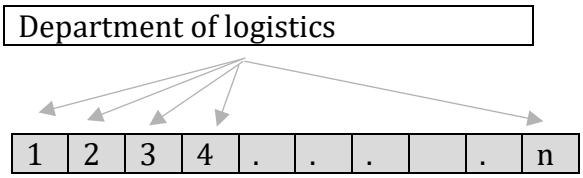
Individual elements of a logistics system [subsystem] must be grouped for their better management into special formations [links of the logistics system], where they can be managed in a similar way. These formations create then their own logistics structure, for example the formation of storage, transport etc.

The aim of the logistics system [Pernica, 2004] is coordination, synchronization and a complex optimization of material and non-material activities of chains, in which the actual and future mission and the source of massive effects can be seen, with the results of massive effects for enterprises.

Possible arrangement of logistic elements into a logistic system and their management (own source)

Figure 2.13

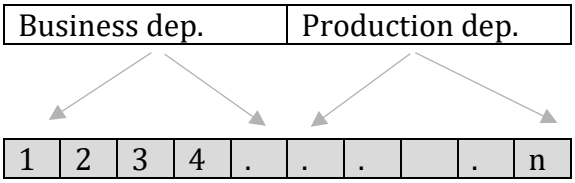
1. One level logistics system



All activities are managed by a department of logistics (or only one person in small firms)

Figure 2.14

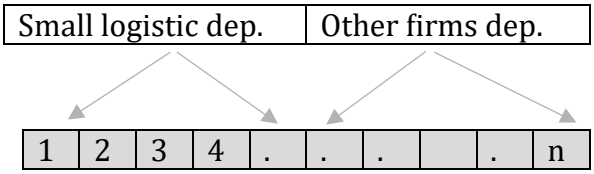
2.



When the department of logistics does not exist, other of the enterprise's systems ensure necessary logistics activities (business, marketing, production...)

Figure 2.15

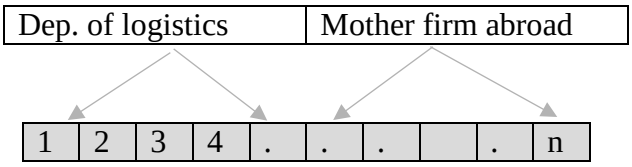
3.



Some enterprise's activities ensure a small logistics formation, the others are transferred to the competency of other enterprise systems (business, marketing, production) or they become quite independent.

Figure 2.16

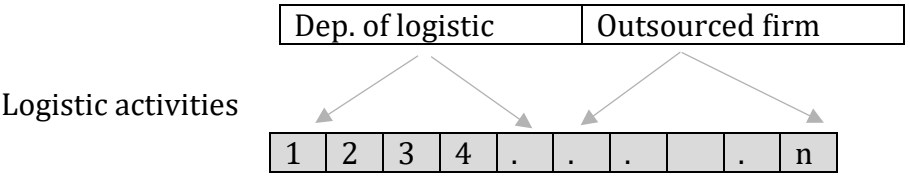
4.



The mother enterprise (often abroad), keeps some logistic activities, others are ensured by a logistic department.

Figure 2.17

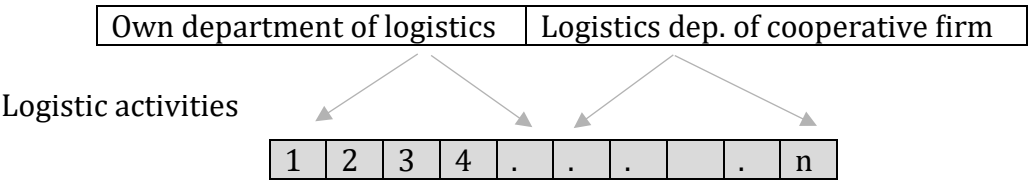
5.



Some logistic activities are transferred to other firms as outsourcing.

Figure 2.18

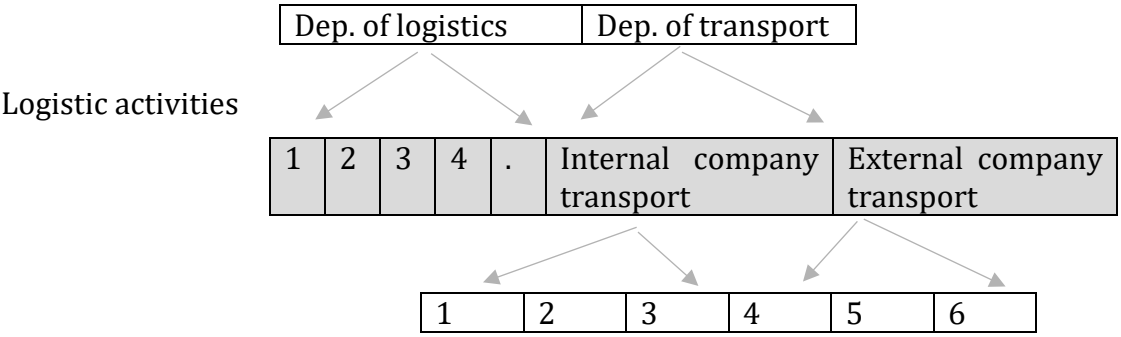
6.



Some logistic activities are managed together with other firms as cooperation (integration)

7. More levels of logistics systems

Figure 2.19



More levels of arrangement:
The central department of logistics manages only some activities and for others there is established a special department (for example transportation), which can form and manage still smaller formations.

IMPORTANT FEATURES OF THE LOGISTIC SYSTEM

- Complexity – a change of one element evokes changes of other elements.
- Homogeny – non-adequate elements and relations must be eliminated.
- Compatibility – mutual quantitative and qualitative harmony among elements.

- Adaptability – ability to change together with changing external and internal conditions [when a new objective appears].
- Synergy – the effect of a logistics system as a complex is greater than the sum of effects of its individual elements.

Some Indicators for evaluation of the Supply chain as a complex (selection).

- Production form (mass, number of pieces, series, project).
- Number of links in the SC.
- Production costs and the share of costs on the final product according to individual links of the chain).
- Key link (links) of the SC.
- Critical link (place) in the SC – TOC (Theory of Constraints).
- Price for the customer.
- Delivery time (days).
- Performance of the SC in a given time period.
- Number of pieces in the batch, number of batches during the year, etc.

Questions

1. Which from the following operations are of non-technological character? Cutting, welding, controlling, painting, packaging, transportation, assembling, weighting?
2. What can be considered as a link in the Supply chain and what only as an element? The warehouse, railway station, fork-lift truck, group of 3–5 workers, production hall, workshop, operator at the machine, a van, transportation group of trucks?
3. What is more advantageous for the producer and why?
   - When the supplier delivers to the producer at about 20% of his production volume, or
   - When the supplier delivers to the producer at about 80% of his production volume?

4. How do we distinguish the key link in the Supply chain?
5. Which are the two basic sources (levels) that help us to define the necessary logistic activities in a firm?
6. What is the difference between one level and more levels of arrangement of logistic activities in a firm?

3 Methods of supply chain investigation

Chapter objectives

- A method is a prescribed procedure to reach the aim.
- Methods of Supply chain investigation are usually the same as methods of investigation of its parts – the links.
- It is difficult to reach the necessary data of all links in the SC, so usually only neighbouring links can be compared one with the other.

3.1 Method of analysis and synthesis of a supply chain

1. Analysis of actual situation
   - Go out of the enterprise's strategy and goals.
   - Delimit the borders of a logistics system (if only one enterprise should be investigated or the whole SC).
   - Assemble and evaluate all necessary input information, get acquainted with actual operations of the system, its advantages and disadvantages. Find out its constraints.
2. Synthesis of an improved SC
   - Answer the question: What happens, if… (some changes occur) Formulate more alternatives (with improved parts and the possibility of eliminating unnecessary waste.
   - Choose the optimal alternative of strategic conception.
   - Elaborate this alternative into more details.
   - Add more information to the chosen alternative.

- Realize the new alternative.
- Perform routine operation with new alternative in improved SC.

Method of analysis and synthesis is described in more detail in Chapter 4.

3.2 Value added in the supply chain

Logistic activities do not add new value to the product, but there are three exemptions. The following activities can add value to the finished product:

- Value added to the form. When the warehouse receives from the producer finished goods in a big form [5 kg piece of cheese, 1 kg of salami], some workers can make of it smaller packages, which can be used just in shops [100–200 g packages]. The final product does not change its substance, but receives a higher value.
- Value added to the place [location]. Logistics transports finished products according to the wishes of clients, so clients have not to do this operation themselves.
- Value added due to time. [to deliver the product just at the ordered time, not earlier, not later].

It is interesting how much value is added to products produced in different states. The lower share of value added shows that products are assembled more of parts delivered from abroad and not produced at home. Value added in different countries on their exports in percent:

Table 3.1 (Hospodářské noviny, 2015)

USA	90
Great Britain	87
Austria, Germany	75
China	70
Czech Republic	60

When analysing this situation in the Czech Republic [2009], the Finance sector has the greatest value added.

Table 3.2 (Hospodářské noviny, 2015)

Finance	87
Trade	82
Mining and building	80
Food processing industry	73
Engineering	66
Chemical industry	60
Transport and communications	50
Electronics	34

Electronic has the smallest share of value added, because most components are delivered from Korea, China, etc. and in the Czech Republic they are only assembled.

3.3 Key link in the supply chain

The key link manages the SC or only a part of it. By finding investigating the key link we can observe, how it manages the SC and if the methods used are effective. The method of using the key link to manage the Supply chain was described in chapter 2.

3.4 Partnership

Partnership is a higher form of cooperation:

- between 2 or more subjects engaged in the same activity, where they represent equivalent subjects;
- they conclude an agreement of cooperation for a longer time than 1 year;
- this cooperation brings them a higher effect than can be reached without cooperation.

The presumption for organizing a partnership is mutual trust, sharing of information and a big amount of orders.

Example of partnership: between the dairy and suppliers of milk (farmers); production of automobiles and suppliers of their parts. The origin of a real partnership between links of the SC is usually a critical problem. Many enterprises are afraid of sharing information due to the possibility that it could be misused.

3.5 Division of labour and outsourcing

Division of labour – a never ending process of the division of different production- or managerial activities, proceedings and operations, into smaller parts, which are assigned to and executed by different workers. Because only a smaller part of the total work is now done by specific workers, there is simpler training and higher performance.

Examples of work division in history.

Town – village (craftsmen and farmers), but they produce the products themselves from the beginning to the end.

Assembly lines in industry. Ford started with assembly belts in the car production industry.
Process of assembly was divided into smaller operations and tasks.

One example of labour division is also Outsourcing.

OUTSOURCING
Outsourcing means to hand over some less important activities from one enterprise to another specialized firm [transport, accounting..], which can perform them with higher quality and at lower costs. Both partners can concentrate only on their principal and most important activities. Some results from our own investigation (Vaněček, 2013):

- Small enterprises use outsourcing less [40%] than greater enterprises (77%),
- Most often accountancy was outsourced [25%], maintenance (23%), and transport (26%). Then followed marketing (12%).

Table 3.3 Outsourcing (%)

Number of employees	Number of enterprises	Outsourcing used in %
1–9	20	40.0
10–24	61	42.6
25–49	35	45.7
10–49	96	43.8
50–249	61	77.0
1–249	177	54.8

Source: Vaněček, 2013

All categories of enterprises use outsourcing. A significant increase appears in the category of middle sized enterprises (50–249).

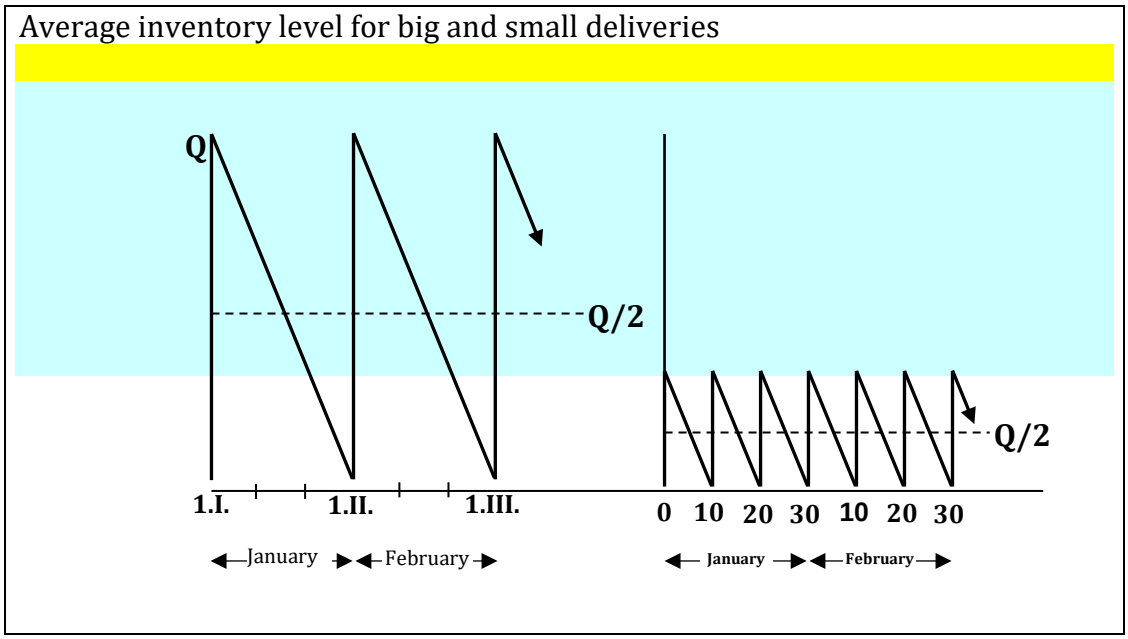
In family enterprises (to a max. of 9 employees) there appear only 0.65 outsourced activities per one enterprise; in the category with 50–249 employees, it was 1.88 outsourced.

3.6 Just-in-time system (JIT)

The JIT system serves to decrease inventories in enterprises and to improve their organisation.

- Inventories must be available, when needed, to provide high quality customer service. But inventories can hide, or cover up bad management (untrained operators, defective deliveries, much rework, breakdowns of machines).
- Difficult forecasting of inventory amount:
  - increased customer demand,
  - delayed deliveries of raw materials from suppliers,
  - breakdowns of some machines or assembly lines,
  - absenteeism of workers etc.
- Negative role of inventories: high costs of storage.

Figure 3.1 JUST-IN-TIME and inventories



Own source

Deliveries of big batches present high levels of inventories (average inventory = = half of delivered batch quantity). The level of average inventory is higher if the delivered quantity comes only once a month, but it is substantially lower, if this months' quantity is divided into three parts, each delivered after ten days.

JUST-IN-TIME (JIT) organizes all activities to occur at exactly the time they are needed.

NECESSARY ASSUMPTIONS FOR INTRODUCTION OF JIT

- Fixed, steady rate of production – not variations, extremes.
- Small lot sizes, but very frequent deliveries.
- Preventive maintenance of machines, quick repairs.
- Multifunctional workers (when there is illness - substitute one for another).
- Reliable suppliers (keep to terms).
- Continual improvement (remove all that obstructs a continual material flow).

When problems are promptly solved, fewer inventories are needed.

CAR PRODUCTION and JIT SYSTEM

JIT = zero inventory – only a slogan.

Assembly line – daily production for example 500 cars.

Necessary parts must be delivered in an exact time, according to detailed plans = = JIT.

How to ensure it?
Near the assembly line hall the producer has a warehouse with all necessary parts for 5–10 days production. From this warehouse the assembly line receives material in the Just-in-Time system. At the assembly line – there are no inventories, outside the assembly line – inventories must exist, but very low.

BENEFITS OF JIT SYSTEM

- Reduced level of "in-process" inventories.
- Reduced space requirements.
- Increased quality of products.
- Workers' participation on solving problems.

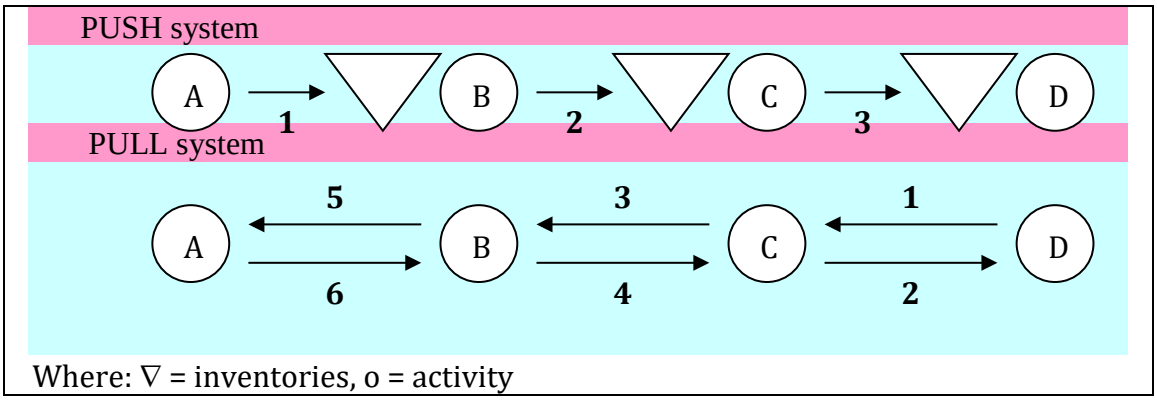
- Pressure to build up good relationship with suppliers.
- Etc.

Negative experience:
Short time deliveries can cause traffic jams in towns.
For example, bakeries deliver bread and pastry several times daily to super- and hypermarkets.

APPLYING THE JIT SYSTEM
Step by step, as problems are solved.
Bad procedure: top manager prohibits keeping inventories (problems were not solved, material flow soon stops). In such cases workers make their own inventories (black inventories). First step to introduce the JIT system: keep the workplace in order, remove all waste, including wasted time, try to have good maintenance of machines.

3.7 Traditional system (PUSH) and JIT system (PULL)

Figure 3.2



JIT and PULL systems

Close connection:
Push system: work-in-process material is delivered to next workplace with no regard if it can be immediately used, if the workplace is ready to accept it (from workplace A to D).

Pull system: material is delivered to the next workplace only when needed, it is pulled, ordered usually by means of Kanban cards.

No delivery, unless the next workplace demands it (from workplace D to A).

Result:
Some workplaces (links in the Supply Chain) must stay inactive sometimes, until there is demand for their products.

PUSH system – only according to the plan (with no regard to actual changes).

PULL system – only according to the client's demands (external or internal).

3.8 TOC – theory of constraints

The Supply Chain consists of different links with different performances. The link with the lowest performance affects the performance of the whole chain. We must try to remove all obstacles which prevent this critical link from having 100% performance. Always there must be a sufficient stock of work-in-process materials so, that this link must not stop.

The next step is to strengthen this link- for example by adding a new machine to it. Imagine the assembly line with 5 different machines and the following theoretical performance per hour:

4 – 2 – 5 – 3 – 4

What is the possible performance of this assembly line? Only 2, because the next machines cannot use their own theoretical performance, while the performance of the critical link is only 2.
More information in Chapter 8.

3.9 Method ABC – management of inventory

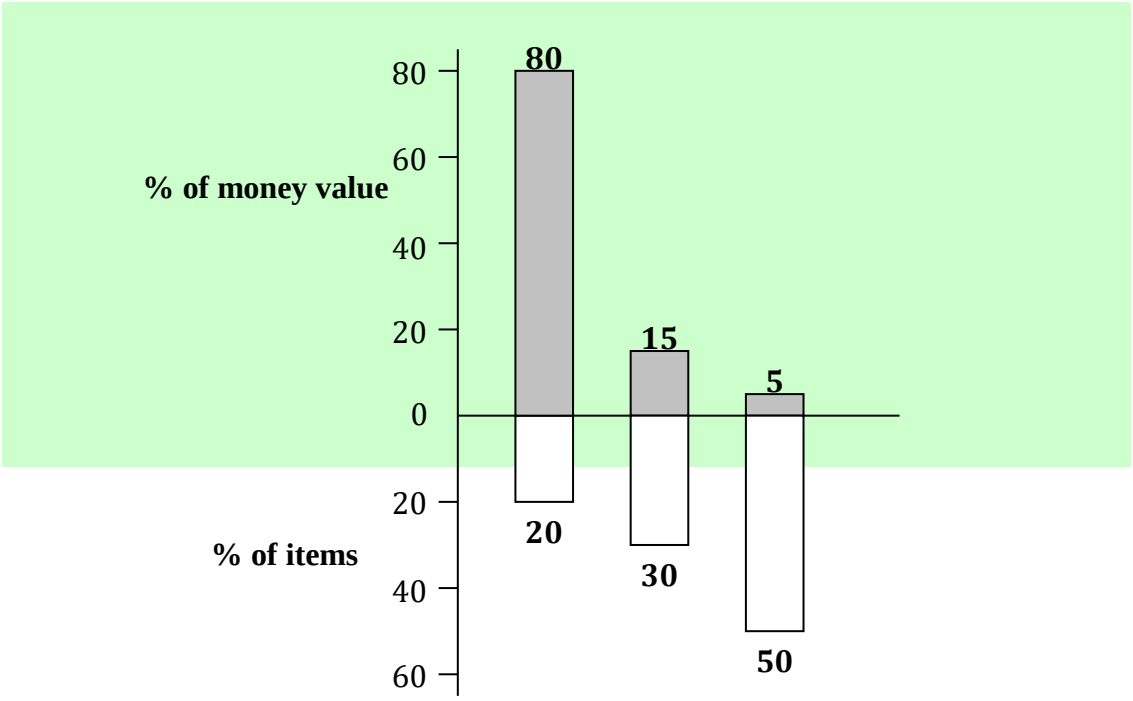
The Pareto rule: 80 : 20. That means:

At about 80% of results, consequences are produced by 20% of causes only. Examples:

- 80% of the stock turnover makes only 20% of items,
- 80% of railroad passengers travel only on 20% of all rail routes,
- 80% of medicaments are consumed only by 20% of patients etc.

Conclusion: to focus only on these 20% of items and so manage all problems. ABC analysis – puts items into categories (A,B,C) that show their relative importance (typically the amount of effort worth spending on inventory control).

Figure 3.3 Typical ABC breakdown in percentage of money value and percentage of items by category A, B, C.



3.10 Choosing the best suppliers

A big emphasis is given to choosing the best suppliers, with which we can make good partnership relations. There are some methods of how to choose the best. But it is necessary to control all suppliers at least 1x per year, if they deliver goods according to concluded contracts and evaluate the supplier regularly.

Results of evaluating should serve to improve their work, so it is necessary to inform them about things with which we are not satisfied, but to tell them also, if we are satisfied with their work.

Permanent review of the suppliers

Table 3.4 Evaluation of Supply contracts' performance

Production specialization	Number of firms	During 3 months	During 6 months	During 1 year only	No ranking
Foodstuff	33	18	4	7	4
Consumer goods	35	11	6	13	5
Construction	14	2	1	8	3
Engineering	34	11	7	13	3
Total	116	42	18	41	15
%	100.0	36.3	15.5	35.3	12.9

Firms specialized in foodstuff evaluate their suppliers in a shorter time than other firms.

Source: Vaněček, 2012

HOW TO MONITOR SUPPLIERS' PERFORMANCE?
What to monitor?

1. costs,
2. delivery,
3. service,
4. quality.

To reward good suppliers – this is a less expensive affair.

- Award by title „The supplier of the year".
- Give gold, silver, bronze medal.
- Make publicity. Suppliers appreciate it.

They will try to satisfy the production firm in the future, too.

CORRECTING BAD PERFORMANCE (WORST SUPPLIERS)

- Schedule a meeting with such suppliers.
- Prior to the meeting: tell them what will be on the program (They must be ready to answer, know the explanation).
- Don't create an atmosphere of hostility.
- Inform to them: we all will benefit from such a meeting.

- Prepare to end the meeting with an agreement:
  - What action to undertake.
  - Set a time for solving the problem.
  - Plan ways of measuring, checking this agreement.

REPLACE OR CONTINUE WITH THE WORST SUPPLIER?

When our effort fails, then seek to replace the supplier with one who can meet our expectations.

Be careful: we can end up with the same problems when switching suppliers.

Better way: improve them (take corrective measures) rather than change suppliers every 3 months.

Table 3.5 Information for suppliers about their ranking

Production specialization	Number of firms	Ranking already	Negative results only	No back info to firms
Foodstuff	31	10	15	6
Consumer goods	32	8	16	8
Construction	11	2	6	3
Engineering	31	13	13	5
Total	105	33	50	22
%	100.0	31.4	47.6	21.0

Many firms don't inform their suppliers about their negative evaluation results.

Source: Vaněček, 2012

3.11 Logistic services

The importance of logistic services for competitiveness is high. Services can be imitated only with difficulty, in production it is easier. Services can be categorized as:

- Pre-sale services.
- Services during a sale (personality of the service staff, possibility to test the product etc.).
- After sale services.

It is necessary to constantly try to improve services, not only to concentrate on improving production.

Questions

1. Which detailed steps would you take when using the method of analysis and synthesis (example: should we buy or not a new machine?).
2. Why is division of labour and outsourcing so advantageous for firms?
3. Is there any difference between the Just-in-time system and the PULL system? Compare them.
4. Explain the ABC method with an example.
5. When a firm uses a Decoupling point in production and waits to receive orders, what would workers do? Go home?

4 Process of supply chain analysis and synthesis

Chapter objectives

- Analysis followed by synthesis is the basic method for improving everything.
- Here it will be used as an example of how to investigate and then improve the process in a bakery.

The process of SC analysis and synthesis can be applied:

1. On already existing chains.
2. On projected chains when a new product is being prepared for manufacturing or when a new entrepreneur enters the market. In such a case, analysis doesn't come from surveying the special situation in the firm, but from generally known or predicted conditions and standards. The latter possibility is shown in the next example, concerning construction of the supply chain model for a bakery.

4.1 Process of analysis in a bakery firm

4.1.1 The strategy

The strategy of the bakery firm is oriented completely within the region where the bakery is situated. No delivery to distant clients is intended. Goods will be delivered both to small retailers and to a great international supermarket in the same region.

Daily bread should be manufactured as mass production using demand forecasting. Pastry should be ordered in advance. Durable pastry (biscuits, crackers) will be produced for a warehouse.

4.1.2 Production and clients structure

Coming out of the strategy, the following 4 different processes appear with the following demands and clients:

1. Production of daily sorts of bread and delivery to a big supermarket.
2. Production of daily sorts of bread and delivery to small retailers.
3. Production of durable pastry (biscuit, crackers) and delivery to the warehouse, which then requires further distribution.
4. Production of pastry on order and delivery to selected shops (confectioners').

Clients are divided into 4 groups:

- supermarkets,
- local retailers,
- warehouse,
- confectioners'.

Each group demands different levels of services, first of all the quantity and then the number of deliveries per day.

4.1.3 Necessary levels of services

It is necessary in all cases to manage firstly the quality of delivered goods, which must be fresh, in a perfect state and shape. For delivery of daily goods drivers must know places of unloading, which reduces frequent changes of drivers. The level of services determines the number of deliveries to the client per day and the delivery of the ordered quantity and structure of products. A standard quality of goods is expected.

Quality indicators:

- number of deliveries per day,
- on time deliveries,
- complete deliveries,
- standard quality of products.

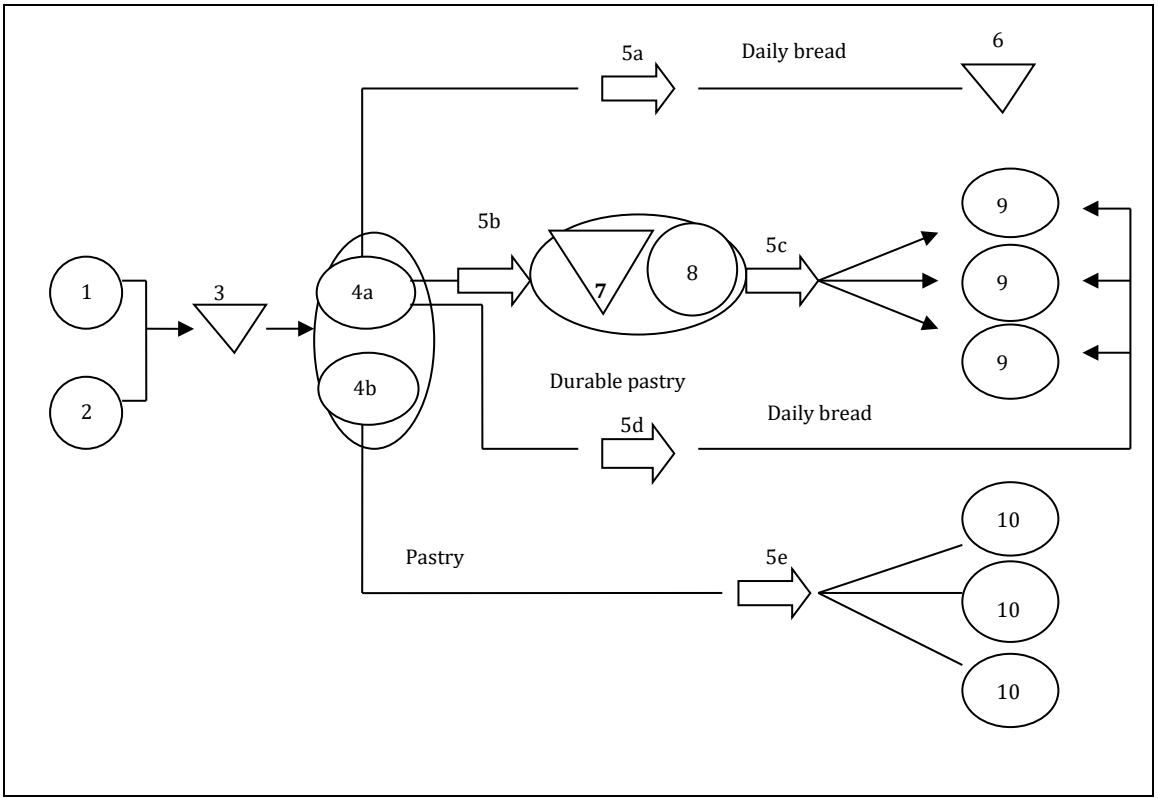
Number of deliveries per week (6 working days):

1. Supermarket: delivery 2–3x per day (for purposes of calculation 2.5) according to the demand of the client, always at the same place ("exclusive distribution").
2. Common retailers: 1–2x per day (for purposes of calculation 1.5), according to capacity of their shops (overall distribution).
3. Warehouse: 1x per week (0.17x per day).
4. Confectioner's: 3x per week (for purposes of calculation, 0.5 per day, – "exclusive distribution").

At the same time it is necessary to collect detailed data concerning clients, suppliers of raw materials, planned and improved services to clients, new assortments, retailer capacities, access to them with vehicles, and most importantly of supply chain management. These data should be used for specifying the production program, setting out the level of services, possible outsourcing etc.

4.1.4 Material flow and its borders

Figure 4.1 Existing Material flow in the bakery



Own source

Legend:

1. Suppliers of raw materials
2. Suppliers of packaging
3. Receipt of material and storage in the bakery
4 a) Bakery's production
4 b) Confectioner's production
5 a) Transport to supermarket
6. Receipt in supermarket (temporary storage)
5 b) Delivery to wholesaler's warehouse
7. Wholesaler's warehouse
8. Association and shipping
5 c) Wholesaler's vans - transport
9. Retailer shops
5 d) Distribution of bread to retailer shops
5 e) Distribution of confectioner's products
10. Confectioner's shops

It is necessary to draw the supply chain scheme with its important links – see picture. The picture 4.1. represents a network of all included processes and their important parts, as places of transformation, transport, storage. It also includes the main suppliers of raw materials and main customers or customer groups.

Setting the borders of the logistic system

The simple scheme (see Fig. 4.1) enables the part to be marked, which can be influenced in some way by the bakery's management. It makes no sense to plan for links 7, 8, 5c, 9, which are in the competency of the wholesaler. Links nr. 1, 2 (suppliers of raw materials or packages) should be mainly reviewed from the view of delivery of necessary materials, their timing, and volume of batches, but with regard to this example of a model, that part will not be specified in detail here.

4.1.5 Value added creation

It is necessary to have only such links in the supply chain which add value. This value can have:

utility of form (F) - what exactly the customer demands,
utility of place (P) - bring goods near to consumers,
utility of time (T) – delivery in time.

Table 4.1 The share of SC links on value added

Link	3	4a	4b	5a	5b	7	8	5c	5d	5e
Value added	0	F	F	P,T	P,T	0	F	P,T	P,T	P,T

It is clear that in this table only the links “storing raw material” or “storing final products” do not add value. Investigating a real, and not a model situation there would occur more often such unnecessary links or unnecessary elements of links which should be excluded from the SC. In our case the store for delivered raw material can perhaps not be eliminated, bur inventories in it should be at an optimal level.

4.2 Process of synthesis in a bakery firm

4.2.1 Outsourcing – its possibilities and proposals

Referring to Figure 4.1, it is possible to review which links (activities) would be possible to pass on to services in the form of outsourcing. Surely, this cannot be the actual production of the bakery itself (4a, 4b), this is a key activity and it must be kept in the firm. It is possible to transfer only some parts of transport.

5a: This transport is undertaken 2–3x per day. A supermarket often calls unexpectedly for an additional supply. For this reason, transport must be operated by the bakery. Passing this activity to any other firm would make deliveries more time consuming with time delays. Of course, it is a theoretical possibility to outsource this activity, but another firm would have to keep its own transport means in the bakery for a prompt service.

5b: Supplies of durable goods (crackers, biscuits) are periodic and take place 1x per week. Their volume is not large. Transport can be undertaken as outsourcing or can be retained in the bakery.

5d: Daily distribution to a wide, extensive trade network. This activity can be passed on to another specialized transportation firm or can be retained in the bakery.

5e: Delivery of confectionery. Distribution is not extensive and is irregular. More likely it should be ensured by the bakery’s own transport service.

4.2.2 Alternatives to review

Possible alternatives have the same basic scheme, they differ only in the ways of transport distribution.

1. Bakery provides all transports of own products (5a, 5b, 5d, 5e).
2. Bakery provides only distribution of confectionery (5e), other transport passes on to a transport firm.

3. Bakery provides transport to supermarkets and transport to confectioners (5a, 5e). Other transport – transport of durable pastry (5b) and transport to retailers (5d) is shipped using a specialized firm.

4. Bakery ensures transport to supermarket (5a), transport of confectionery (5e) and of durable pastry (5b). Transport to retailers is done by a transport firm.

It would be possible to create other alternatives, for example to stop confectioner's production or establish a quite new production. At this stage, the firm must be able to answer such questions as follows:

- What happens if we end cooperation with the supermarket?
- What happens if we pass a part of our activity to another firm?
- What happens if we start production of a special bioproduct?
- What happens if we deliver goods to neighboring regions, too? Etc.?

All these considerations are decided not by means of calculation at this stage, but only by the use of available information. Questions and answers should be found by a team of managers with different specializations, such as manufacturing, logistics, marketing, finance etc.

4.2.3 Selection of the optimal alternative

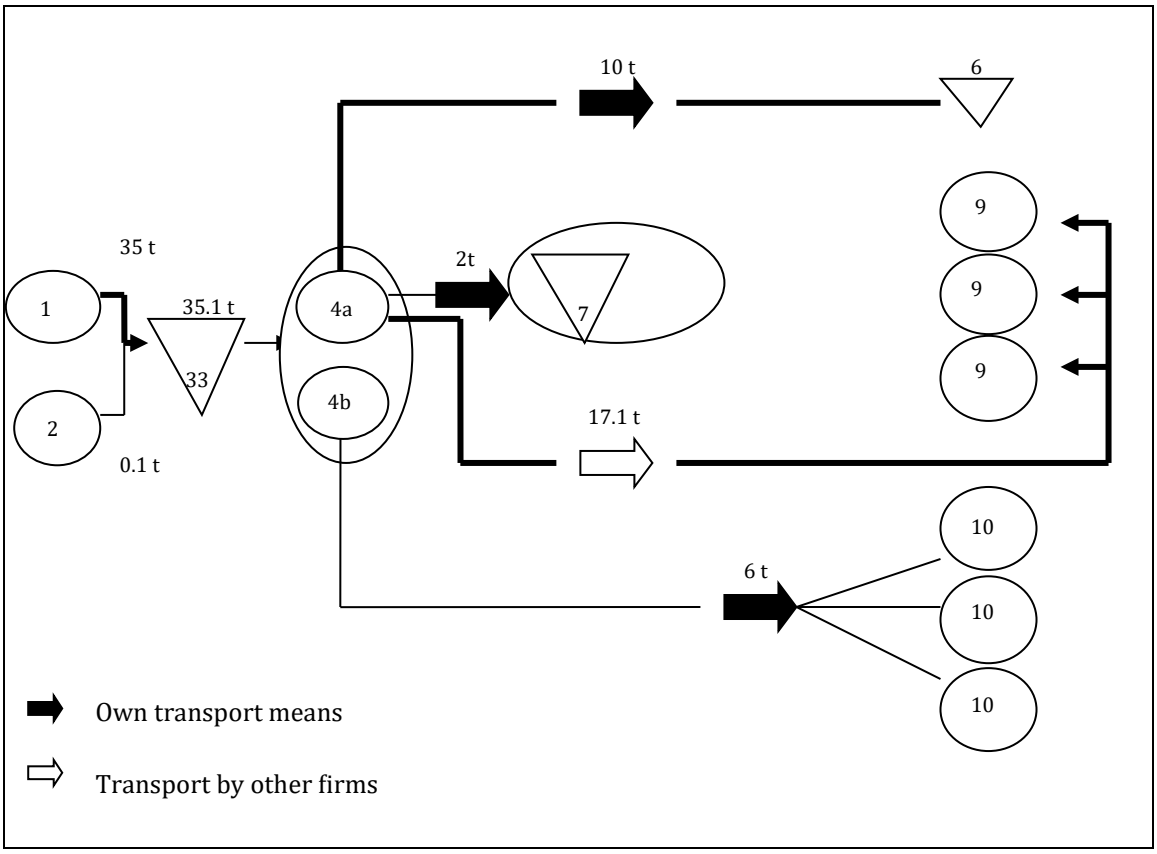
Let us imagine that from proposed alternatives, we later selected for example alternative Nr. 4 as optimal. That means, the bakery will ensure distribution for supermarkets and the transport of pastries (5a, 5e) and for the warehouse (5b). Transport to a number of small retailers should be outsourced to a specialized firm.

4.2.4 Quantification of material flows

To determine the manufactured volume of goods and necessary number of transport vehicles, we need first of all, to characterize individual material flows with their expected volume in a day (or week or year).

Every day 35 tons of material is processed. The quantity of packages in the bakery is at this stage of our investigation insignificant and we will not calculate it. The material volume is in the next picture.

Figure 4.2 Material flow – selected alternative



Own source

Alternatives of distribution

Formerly we selected from four possible alternatives the alternative Nr. 4 (bakery provides transport to supermarket – 5a, transport of confectionary goods – 5e and of durable pastry – 5b). Transport to retailers is provided by a transport firm. But this only seemed to be the best solution, without giving perfect reasons for it. Further we must try to support this alternative by a calculation.

The baker's van should have a loading limit 4 t, but a full load with bread and pastry makes only 2 t. By means of the transport cycle time (loading, run with load, offload, backward run) it is necessary to calculate the number of cars (drivers). Length of the workshift = 420 min.

1. Material flow for client (Nr.6) – bread for supermarket
Daily sales of 10 tons bread must be distributed 2.5x per day.
Transport cycle = 100 min (estimation).
One van:
1 run ……100 min ……..2 t
Because we need to deliver 10 t daily, we need 5 runs with the total time 500 min.

2. Material flow for the client (Nr.10) – delivery of pastry
Deliveries 3x per week, always 2 tons = 6 t per week, that is 1 t daily.
1 run ……300 min ……2 t
Because we need to deliver 1 t daily, we need 0.5 runs with the necessary time 150 min.

3. Material for the wholesale store (Nr.9) – durable pastry
Distribution 1x per week, 2 tons.
1 run ……180 min ……2 t
Number of runs per day: 2 : 6 = 0.33
As we need 0.33 runs daily, the necessary time will be 180 * 0.33 = 59.4 min.

Because distribution to small retailers will be provided by a specialized firm, the total daily time consumption for bakery transports makes:
500 + 150 + 59,4 = 704.9 min.
Number of vehicles (vans) = 704.9 min : 420 min working shift = 1.68
There are 2 vans per day necessary for distribution.

Material flow into the retail network is provided by a specialized firm. It is necessary to approve the time schedule of distribution, because all shops must be fed at least 1x per day, the largest 2x per day. The time schedule should ensure the transport of fresh goods to all shops till 10 o'clock a.m., with preference given to the largest shops.

It is recommended to complete alternatives of distribution by reviewing what vehicle will be the best for transport of bakery goods. There can be vehicles with different loading limits, different loading space etc. We can also research if purchasing or leasing the vehicle will be the best solution.

We must also be sure of the quality of distribution which is provided by another firm. That means, the firm cannot have only one vehicle, because in case of a defect, distribution cannot stop. The next problem is the character of the goods, which have different weights and cannot fully use the maximum load capacity of vehicles.

4.2.5 Alternatives of levels of customer service

Customers must be fully satisfied. So the calculated alternatives must be reviewed also from other aspects, not only from the view of transport. The necessary satisfaction of customers must be fulfilled at least in these points:

- acceptable prices of goods,
- broad offer of goods,

- quality – delivery of fresh baked goods, in time, delivery of demanded quality and structure of products.

The two first options will not be discussed here, as they are issues of contracts between suppliers and producers.

Quality depends firstly on the frequency of deliveries, which ensures that shops and also end consumers will always have fresh bread. The bakery must produce small production batches several times a day, according to the demand. If any shop sees that bread will soon run out, the bakery is prepared to produce extra batches and deliver them, of course, only in a certain limited amount. At the same time it is necessary to consider withdrawing unsold goods.

Similarly just as we considered distribution options, so it is also necessary to look at other possibilities if they come into question, for example alternatives to storage, information flows etc.

Implementation of chosen alternative and daily operating activities follow after approval of this analysis.

Questions

1. Which are the necessary steps in Supply Chain analysis?
2. Which are the necessary steps in Supply Chain synthesis?
3. Describe the routes of material flow in the picture 4.2.

5 Examples of supply chains

Chapter objectives

- Different branches of a national economy have different specifications of their supply chains.
- A flower auction in Aalsmeer represents an integrated chain, where the key link is not the manufacturer, but the auction.
- The chain of production and sale of meat and meat products represents the possibility of integration of some links of the chain.
- The chain of footwear sales shows that the key link can also be a small marketing department only.

5.1 Flower auction Aalsmeer

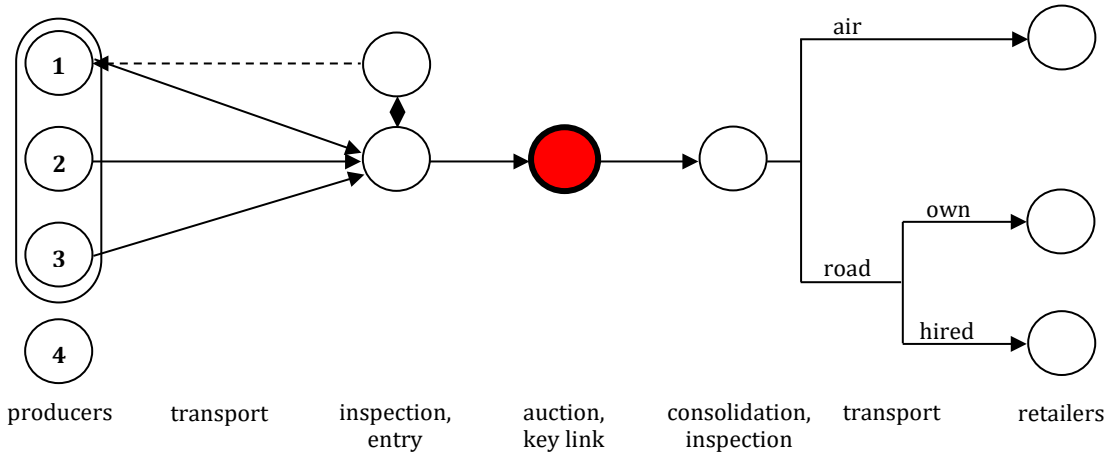
INTRODUCTION

- The Netherlands – small land area.
- Necessity to focus on intensive cultivation of flowers with higher economic profit than other crops [using greenhouses].
- Importance of a good strategy; support of logistics.

CHARACTERISTICS OF THE AUCTION

- 5000 flower producers are members of the association,
- key link of the SC is the flower auction:
  - huge building, 750 000 m^2, = 125 football grounds, 800 x 600 m
    * has only ground floor,
    * under the roof – path for tourists,
    * member's contribution – 5% from profit gained.

Figure 5.1 Diagram of material flow in the supply chain



See: 1–3 = members of cooperation, 4 = other producers

Own source

ACTIVITY OF INDIVIDUAL LINKS
Producers [farmers]:

- Harvest of flowers runs in the evening [or early morning].
- Early morning farmers transport flowers to the auction storage.
- Storage in cooled rooms on small carriages [as in railway stations for luggage].
- Quality control remarks – on the form (card), which accompanies each carriage to the auction.

AUCTION HALL

- Auction starts at 6.30 to max. 14.00, when all is sold.
- 5 special auction halls are in the building, each for 350 clients.
- Auction clock with one pointer only – moves from maximum price to zero.
- The client has an identification card, it serves as his registration and access to the buyer's push button.

ROLE OF THE ASSISTANT

- Carriages drive continually through the hall, one carriage = 1 batch which should be sold.
- Assistant under the clock takes out one bucket from the carriage and presents it to the auditorium.
- Then the form [card] of each carriage is inserted into the computer.
- On the display appears the necessary information [kind, variety, quantity, quality, origin etc.].
- Pointer of the clock starts to move.
- The client who pushes the button first, receives this batch of flowers.
- 99,5% of all flowers are sold.

INFORMATION FLOW

- After pushing the button all information goes both into the central computer and on the display under the clock.
- The computer processes data, prepares the invoice for the client, calculates accounts for the growers etc.
- Every hour 500 transactions [sales] can be made here.
- Carriages do not stop anywhere and are driven to the shipping bay.
- After each transaction a card is printed for the carriage with the address of the client and with other necessary data.

Figure 5.2 Auction hall from visitors' view

Source: Info leaflet on the auction

SHIPPING BAY

- Flowers are divided according to the clients with the aid of printed cards on them.
- Flowers are packed and transported to the ramp.
- Lorries are prepared here to distribute them to all places in Europe [24 hours], or to the airport for transporting them to Japan, USA... [48 hours].

Flowers arriving at the auction in the morning can be sold in the evening in other countries in Europe.

STATISTICS

- Every day 20 mil. flowers are sold.
- Number of employees: 1 800 in total [including transport and other activities 12 000].
- On the roof of the auction building there are parking places for 4 500 cars.
- 2 000 lorries leave the auction building daily.
- Every year there are 220 000 visitors.

APPLICATION OF LOGISTICS

- The key factor of the Supply Chain is the auction hall. Other participants (links) must coordinate their activities with it.
- Here the PUSH, not PULL principle of material flows is applied. The association doesn't limit its members as to how many flowers to plant and to deliver. This is possible due to the better competitiveness here than other SCs have – and due to the fact, that the demand for flowers in many countries is not fully saturated.
- Material flow is continuous, it stops only for a short time at the input and output points of the auction hall.
- The cycle time from harvesting the flowers to their sale to customers lasts 24, max. 48 hours.
- Continuous material flow is conditioned by a good information flow. Each batch of flowers is accompanied by a special card with all necessary information, which is processed immediately.
- The farmers receive their money for flowers on their account the same day when flowers are sold.

The good quality of this SC makes it possible that some flower farmers from Africa, for example from Kenya, Zimbabwe, etc. send their harvested flowers by plane to Aalsmeer, where they are sold and then are transported to different places, maybe also back to Africa and sold there in flower shops. In such cases, there is certainty, that all goods are sold. The chain operates so quickly, that the quality of flowers does not decrease.

Figure 5.3 Preparing flowers for auction

Source: Info leaflet on the auction

5.2 Supply chain for processing of pork and beef production

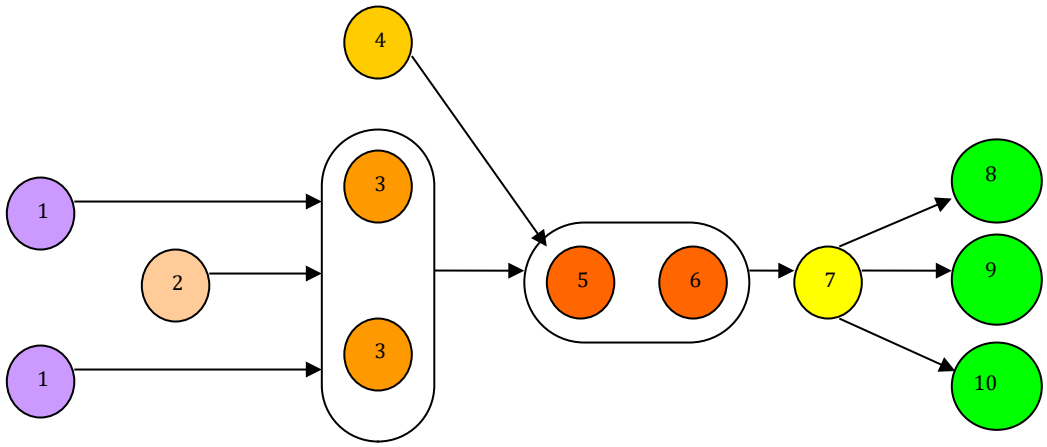
- Almost the whole SC is managed by the key link. The proprietor possesses the majority (or all) links in the SC.
- Such a situation appears in the food processing industry only seldomly, but it makes effective management possible.

Characteristics of the firm
The firm Zooinforma – Týn nad Vltavou. It was founded in 1992 as a slaughterhouse with the subsequent production of sausages and carved (selected) meat.

- The firm had 14 of its own shops, two of them in Prague.
- 2 big fattening pig farms.
- Year's production = 4 300 t carved meat and 400 t meat products and semi-finished products.

- Emphasis is given on traditional raw materials, without adding poultry separates and substitutive additions.

Figure 5.4 Supply chain for processing pork and beef production



Suppliers of piglets (1)	Purchase of fodders (2)	Fattening halls: own (3) and other proprietors (4)	Slaughter-house (5) and production of sliced meat (6)	Transport (7)	Own Shops (8), Other shops (9), schools, hospitals (10)

► directly managed by the proprietor ◄

Own source

Links of the Supply Chain

- Supplier of piglets delivers them in the weight of 25 kg (34–36 days old).
- Supplier of concentrated fodder: the retailer Grana Písek. Concentrated fodder is prepared exactly for different weight categories (tailored production).
- Fattening halls: the proprietor has 2 fattening halls with the capacity of 13 000 pigs and a years' production of 35 000 pigs fattened to 105–115 kg during 130–135 days.

Next the necessary pigs are purchased by means of the firm Agropork from private farmers (36%).

Figure 5.5 Fattening of pigs

Source: Zooinforma

- Slaughterhouse : every year 55 000 pigs and 1 500 beef cattle are killed here.
- Transport of waste is done by the cooperative Jevišovice – and it is used for biogas production.
- Meat production: they produce small lots of top quality. Durability 3 days, when packed in a protected atmosphere, 20 days.

Transport

- Permanent transport lines, everyday use, own transport means.

Orders

- Customers can order (gratis) from 04–17 by phone, fax.
- 35% of meat and 70% of processed meat (sausages) is sold in the firm's own shops.
- This firm does not deliver to big hyper- and supermarkets – because it had to use meat substitutes to keep the price low.
- Number of customers: 150.

Application of logistic principles

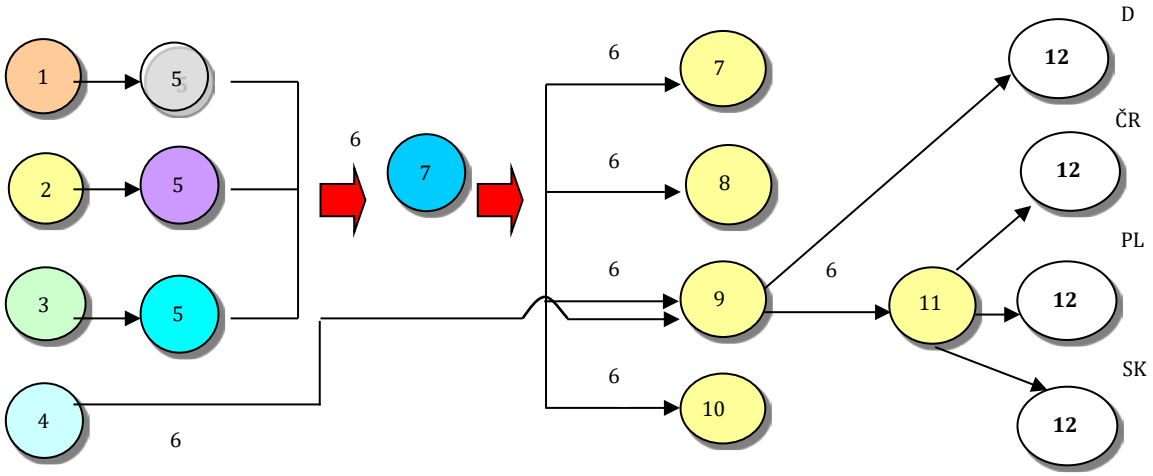
- The proprietor manages the whole Supply chain by means of the key link.
- When a lack of pigs appears, they send pigs to the slaughterhouse with lower weight from their own fattening.
- Partial loss from production is compensated by sales in own shops. Supply chain is managed with regard to the customer.
- Pull principle is used – production only on orders.
- Information flow is based on monitoring of immediate sales.
- Strategic intention: to produce own fodder on fields and process it in own facility? The project showed bad economic results.

5.3 Distribution chain for selling footwear

Production and sale of footwear

- Relocation to countries with cheap workforce.
- But in Europe managers know better the situation of demands, fashion and distribution.

Figure 5.6 Diagram of the distribution chain



1–4	5	6	7	6	7–10	6	11	12
Produ-cers: 1. Chína 2. India 3. Vietnam 4. Portugal	Consoli-dation in ports, loading at an exact time	(Ship) trans-port	Port in Europe	Trans-port (trucks)	Distribu-tion (DC) centres in Germany	Trans-port (trucks)	DC for Czech, Poland, Slovakia	Shops

Own source

Functions of different links: purchase department

- Centre of management in Essen.
- Managers monitor on fair trades new fashion trends in footwear and order them from Asia.
- The firm need not have its own design department of products, nor own investigation of fashion trends.
- Big responsibility – How much to order, what, if goods will not be sold?
- When all is sold already, next delivery of goods cannot be ordered (long time and seasonal goods).

Consolidation

- Goods are produced in different countries of Asia, so it must be appointed in which port there will be consolidation (28 different ports in China, Vietnam, Laos etc.). Here goods from different producers are loaded.
- European market is supplied by about 100 suppliers.

- Cargo ship: 15 000 containers (20 feet), 1 container = about 5 000 pairs of footwear.
- Transport from Asia to Europe lasts about 20–28 days.

Distribution firm:

- Originated in Germany in 1913.
- It has 1000 shops there and expanded to other countries. In the Czech Republic there were 32 shops, others were in the Slovak Republic and Poland.
- Advantage: a distribution firm needs fewer management and other employees than a production firm.

Distribution centres

- Department of purchase and distribution uses EDI – technology – Electronic Data Interchange – (linkage of all users), mainly downstream.
- Goods are delivered to shops immediately, according to the amount of the last sales (forecasts).

Receipt

- Goods are not on palettes, but loaded free in cardboard boxes, to better use the space of the container.
- So containers and palettes need not to be returned. Big cardboard boxes are packed in firm always by smaller 10 boxes with footwear.
- When loading or unloading, only manual method is used – disadvantage.

Distribution centre:

- Sorting goods from containers for different countries. In Germany, there are 4 such DCs.
- Wolfen DC supplies the Czech and Slovak Republics, Poland and a part of Germany.
- Year's turnover: 280 million pairs of footwear in this DC.
- Goods are not stocked, only Cross-Docking is used, then distributed to shops.
- Goods from a container are manually loaded on to a conveyor belt and then on palettes.

- Control: according to the weight of individual boxes. When there is a lower weight, the belt stops automatically.

Transport to retail shops

- Supply to shops 2–3x per week, according to orders.
- Shops receive information that goods are in transport already.
- Transport by means of own trucks or outsourcing.

Application of logistic principles

- The distributor is the key link in the Supply chain – it manages producers in Asia and distribution at home:
- The producer in Asia produces only for fair trades (models), then he waits on orders. He manages only his own suppliers of raw materials. (Of course, he produces for the Asia market too).
- Division of the SC decreases the risk. In Asia, there are lower costs also.
- European distributors should not take care of development and research. The firm becomes "lean".
- Demand forecast is difficult and the responsibility has the distributor. Result of a bad order: Sell with loss or do not deliver goods on the market in time and necessary quantity.

Management of the Supply chain

- Two parts of the SC: Downstream it is managed by contracts with producers in Asia.
- Upstream the distributions centre in Europe follows direct management by means of the firm.
- Reverse logistics: no return of palettes is necessary in marine transport, only containers are used.
- Application of Cross-docking system in the distribution centres.
- Cooperation with firms from Asia has a continuous character, but no partnership is created here. DC looks permanently for new suppliers.
- Supply chain management: the whole SC is optimized, that is production, transport, storage.

Questions

1. Where (in the three described examples) is there the shortest time between selling or delivery of goods and receiving payment for it?
2. Does the Push or a Pull system exist in Aalsmeer Supply Chain of flowers?
3. Aalsmeer's auction: what plays the decisive role in success of this auction? a) quantity of goods sold, b) marketing, c) flexibility, d) speed, e) quality of products, f) tradition of flower cultivation?
4. What are the advantages and disadvantages of such management of the Supply chain, when more links are in possession of the key link?
5. What is the main risk of the described Supply chain model for selling footwear?

6 The material flow

Chapter objectives

- Regarding material, we consider basic and auxiliary material, parts, work-in-process and finished products, waste, etc., in the solid, liquid or gaseous form, shifted loose or in transportation units.
- Material flow is the managed movement of materials, usually by means of handling, transportation and auxiliary machines and facilities, so that the material would arrive at a certain place in the necessary quantity and quality, at the demanded time and with predetermined reliability.

There exist three different forms of material flow:

- Flow in the Supply chain.
- Flow in the enterprise.
- Flow in the workshop.

6.1 Material flow in the supply chain

In the global environment, the flow occurs usually between continents. For example, in Australia or in Africa, there are rich findings in places of raw materials, but no plants to process them. So materials must be transported over long distances, where they can be processed to materials with higher concentrations of the demanded substance. This new material is then sent to specialized plants. Example: Bauxite in Africa or Australia is processed in Taiwan, where the waste of bauxite ore is eliminated and only concentrated material continues in transport to Europe. Because these raw materials represent a big volume and are transported over long distances, it is advantageous to use big batches of them and so decrease the unit costs [Economies of scale].

Beside this, smaller products and work-in-process parts are also manufactured in Asia and transported to Europe. This is because the labour force in Asia is much

cheaper than transportation costs and so the total costs are lower than when manufacturing necessary items in Europe or in the USA.

Conclusion: low wages and big batches make possible the intercontinental transport of many materials.

6.2 Material flow in the enterprise

This flow depends in the first place on the method of production which can be:

- Continuous [steel works, sugar refinery] – operates 24 hours every day and cannot be interrupted.
- Mass production [motor-car industry, production of TV sets]. It can be interrupted into 1-2-3 shift systems.
- Series production (batch production – dresses, footwear]. Different series repeat usually every year.
- Job shop production [special equipment, furniture]. Production of lower volume of products. (Similar to craftsman production, but with the use of labour division).
- Project production [building of bridges, railways...]. Only on order.

The flow of materials from the continuous system to the Job shop system represents:

- Decreasing volumes of materials.
- Increasing costs.
- Higher flexibility.

Project production depends on exact customer demands.

The big influence on material flow is the location of the decoupling point. That is, production can be made in stock, on order, or on the basis of forecasts to the decoupling point, where the work-in-process materials wait for the client's orders, to be then very quickly finished, usually as tailored production, and then delivered.

The terms "downstream", "upstream" are often used here. That means from the decoupling point to the end or to the beginning of the flow.

Analysis of the material flow

The necessary impulse for material to flow is given by the firm's plan [forecasting] or just from the clients' order. Because during the transport no value is added, the management must try to design the flow:

- To be as short as possible, and so decrease the transportation costs.
- Without interruptions [or only with a minimum of them]. Each stop forms a small store, but the sum of such small stores in the flow represent a big amount of inventory.
- Transport of materials over long distances [between continents] is usually undertaken in big batches, so that economies of scale can be gained.
- Transport of materials over short distances (between workplaces) can be made with advantage in small quantities (Kanban) according to Japanese experience, also only as a one-piece flow on the assembly line. Then no work-in-process parts can exist at the assembly line.

6.3 Material flow at the workplace

The form of the flow is given by the layout of machines, stores, buildings, workers etc. There we can distinguish 4 different groups of layouts with different flows of materials:

- Fixed-position layout,
- Process-oriented layout,
- Work-cells layout,
- Product-oriented layout.

A) Fixed-position layout
It is characterized by the fixed place of the end product, which does not move [building a ship, a house, a bridge] and all necessary materials must be delivered to this place. It is necessary to harmonize the flow of materials because there is only a small space for storage and the materials must be used in an already pre-prepared form [not concrete prepared at the site from sand and cement but delivered ready-made concrete]. Then only small inventories are needed.

B) Process layout
Machines with similar functions are grouped together (when one of them has a technical breakdown, the others can continue working). For labour organization this is a good arrangement, but the material flow is longer, from one workshop

[room] to another and then often the flow returns back and the monitoring of it is more difficult. Many storage-places take their origin from this, when waiting for free machine time.

C) Work-cells layout
All workers with necessary machines and tools are divided into some independent groups with their own foreman. The sequence of work operations and division of labour depends partly on workers in the cell. Labour productivity can decrease, but workers are more satisfied, because they can change their work and need not do the whole shift or week on only one task, which is too fatiguing. The material flow is very short.

D) Product oriented layout
This arrangement is used in mass production. All necessary machines are arranged according to necessary operations and are close to one another. Material flow is very short and economical. On the production [assembly] line the material moves in small batches, all pieces of the batch are processed on one machine, then they continue as a batch to the next machine. In the best enterprises there are efforts to have only one item as a batch, so called: ”one-piece-flow”.

When material is processed on the assembly line, it must be delivered ”Just-in-time” to each worker. How to attain this punctuality? Usually, near the assembly line, there is a warehouse with inventories for 5–10 days. From this warehouse to the assembly line, an electric train transports necessary items and parts every 30 minutes. The number of necessary items is ordered by means of Kanban cards.

6.4 Planning the material flow

Operative, short-term plans
They represent a detailed time-table progress chart not only of moving the material, but also of the need for machines and workers. Every enterprise plan has hundreds of different activities, but which of them to start with? Some useful rules:

1. FCFS: First come, first served.
2. Start with the most urgent activities.
3. SPT – Start with activities which require the shortest processing time.
4. EDD – Start with activities that must be done first [early due date].

The following methods have another access to material flow planning;

1. MRP – Material Requirements Planning
2. JIT – Just-in-Time.

Material requirements planning, MRP-I
It is planning backward. When we know the exact delivery time to the customer, we plan backward the necessary steps that must be done:

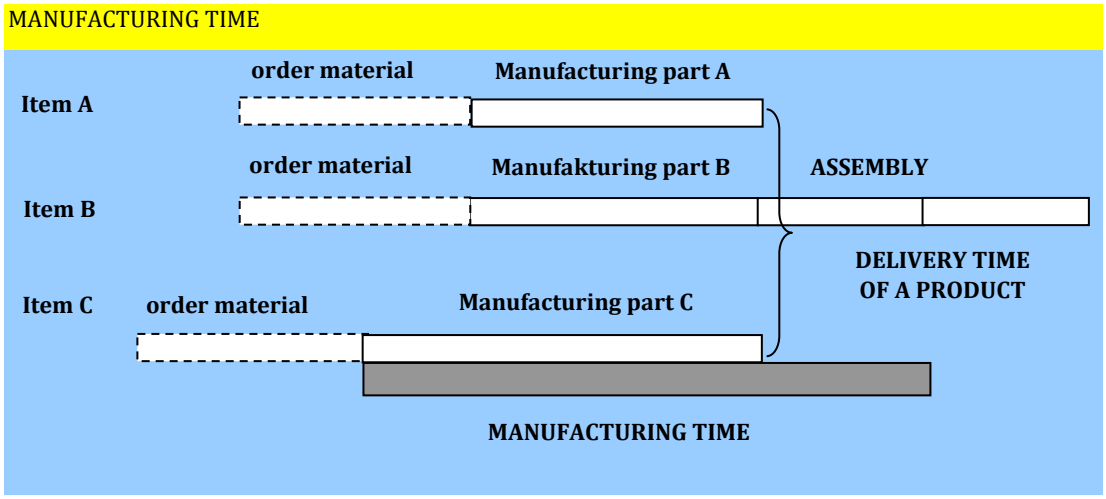
- Time to transport of finished product to the client.
- Time to assemble the final product from different parts.
- Time to produce [buy] necessary parts.

This planning concerns activities performed in the enterprise which assembles the final product, but also neighbouring suppliers.

MRP is a computer based system, which can be extended so that it calculates not only necessary materials, but also necessary workers and machines [and their capacity] – so called MRP II.

Computer programs for MRP II are sold by the SAP company [Germany], but introducing such a system is financially demanding and takes a lot of time [price some millions USD, installation about 2 years]. But it increases the competitiveness of the enterprise.

Figure 6.1 Time in manufacturing



JUST-in-TIME planning
This system is also oriented on decreasing the level of inventories, but does not use such a complicated way of planning as the MRP system. [Example: you call a taxi to come at 8:00 in the morning to transport you to the railway station. If it comes at 7:30, it is too soon, you are not prepared and if it comes at 8:30, it is too late].

The objective of this system is firstly to decrease the level of inventory. Inventories take their origin between operations, because there exists uncertainty whether the previous link [workplace] will deliver demanded material at the necessary time. Inventory makes it possible to arch over this period. With the increase of uncertainty also the amount of inventories increases.

But the JIT system can be not ordered by top management. Firstly when the JIT system is introduced, all potential obstacles must be removed [to have skilled workers, well adjusted machines, good plans etc.

JIT is closely connected with the Kanban method. Kanban is a card, which controls the material flow. In the production the processed material takes steps between different workplaces. The last workplace (Figure 3.2.) [D] starts the process. It sends a Kanban card to the previous workplace [C]. Now C can send the demanded material to D. Because now C has no material to process, it must it demand again by means of a Kanban card from the previous link [B].

So material moves only when the Kanban card [demand] is sent to order the next batch and no unnecessary inventories are formed at each workplace. Each workplace becomes both a supplier for the next link and a client for the previous link.

As mentioned previously, management tries to ensure that not only the material flows fluently, but that sometimes the flow stops for some time. This is when using a “Decoupling point”. Material flows in the enterprise and some work-in-process parts are made, till they reach the decoupling point. This part of the flow is managed only by forecasts. Finishing the product can be a risk, because the producer only estimate, that his goods will be sold. It is better to stop production, find clients and then to finish the product. Products can then also be adjusted according to the wishes of customers, which is called “tailored production”.

6.5 Analysis of the material flow

The main objective is to find out:

- Material handling done by hand.
- Unnecessary interruptions of the material flow.

- Not necessary material handling.

We are interested primarily in the following indicators:

- Intensity of the flow [its volume in items, palettes, trucks, price, during a time period, of usually 1 day or 1 year].
- Fluency [evaluation the fluctuations in quantity during some hours, days, weeks, months].
- Volume of batches in which the flow moves [number of boxes, palettes, trucks...].
- Distance [in meters, kilometres], from the input to the output of materials in an investigated link of the Supply Chain.
- Time, how long materials are present in the investigated link.
- Number of places where material stops [in warehouse or in time-limited storage between workplaces, and average volumes of these materials].
- Find out the critical element [according to the theory of constraints, TOC], which limits the throughput of materials to the next element or link.
- Quantity of materials which must be handled by hand with effort – to eliminate this labour [moving goods on palettes, loading, installing goods onto racks...].

As a result there should be a proposal to decrease the number of stocks [which does not harm production] and to shorten the transport of materials.

To obtain a better orientation of the material flow, we usually illustrate it in graphical form. We sketch it as a line on a ground plan, which is completed by some standard symbols.

 Circle – activity. Material is processed by a machine or only by a worker

 Arrow – material moves from one place to another

 Square – control of quantity or quality

 Triangle – material is stocked [temporarily or for a longer time].

Similar to material flow, we can trace the movement of a worker in the workplace and depict where he is moving and what he is doing. Here we do not use the triangle symbol, but the letter “D” [Delay].

To have a better picture of investigated work, we can add some useful data to symbols in the ground plan: distance in meters, volume of material [batch] in kg or necessary time, how long the task lasts.

The advantage for such a picture is a better overview and simpler decision about which tasks can be eliminated or shortened, for example by adding a new machine or only a worker to some workplace. It is not necessary to make a time study; measuring time can follow later. The hypothesis is: when a certain operation needs for example 20 symbols to be depicted and we can eliminate 2 of them as not necessary, then the improved operation will last a shorter time.

When making a detailed analysis, we usually write the data into a table, where there is more space for useful data than in the graph.

CASE STUDY 1: DIFFERENT WEIGHTS OF PRODUCTS

Amway is a US corporation which processes and distributes household and cleaning products for cleaning around the whole world. They are also sold in the Czech Republic, not in shops, but by means of distributors. They are mainly produced with a higher concentration of effective ingredients than is in other common goods. So they are more expensive, but when the clients dilute them, they receive more doses with a cheaper price per single dose.

This arrangement that enables transport of concentrated substances over the oceans more effectively and without waste water makes the transport more cheap. Beside this, there is also a smaller number of plastic packages, which is good for the environment.

Table 6.1 Comparison of two products

	Amway – USA	Vanish – Europe
Packing	1000g	500 g
Price	420 CZK	219 CZK
Effective dose	10 g	30 g
Number of doses	100	16,7
Price per one dose	4.20 CZK	13.10 CZK

CASE STUDY 2 – PRODUCTION OF METAL TINS FOR COCA-COLA

How does value added increase?

- Necessary raw material – bauxite ore, is mined in Australia.
- Transport. The ideal case would be to mine it in small quantities which would be immediately transported to the next processing point. But economies of scale plays a role here and so big quantities of bauxite are mined

and then shipped by high capacity dumpers to the enterprise, whereby means of chemical reduction aluminium powder is produced.

- The process of changing 4 tonnes of bauxite into 2 tonnes of aluminium takes 30 minutes. Aluminium powder stays there until there is a big stock of it [it would be enough to produce 10 million Coca-Cola tins] then big dumpers transport it to start the 4 week long route to Norway or Sweden [where there is cheap electricity from hydro-electric power stations], where the bauxite ore is smelted.
- After 2 months waiting for the smelting process [of using a big amount of energy – 20 times more than by recycling older tins, after 2 hours, 1 tonne of aluminium is produced from 2 tonnes of raw material. Smelted aluminium is formed into ingots of the size 100 x 110 cm.
- Ingots are stocked for 2 weeks [to have a big batch] and shipped by ship or by trucks to Germany or Sweden to the rolling mill where they are rolled by high temperature technology. The original 1 m diameter is decreased to only 3 mm. This procedure lasts 1 minute.
- Management decided to keep this material till there are orders for big quantities and then to process it all at once. Aluminium sheets are rolled into 10 tonnes cylinders and stocked at the same place for 4 weeks.
- These aluminium sheets are shipped according to orders by trucks to a cold rolling mill [in Germany or Sweden], where they are stored for 2 weeks.
- At the cold rolling mill the thickness of the sheets is decreased from 3 mm to 0.3 mm only, which is needed for Coca-Cola tins. But sheets must again wait, till the orders are big enough for the next processing stage.
- Sheets are cut out to certain dimensions and stored here for about 1 month.
- According to received orders aluminium cylinders are shipped by ships or trucks to the producer of tins in Great Britain. There cylinders wait 2 weeks and gradually are sent for processing.
- Finished tins are sent to a washer, then to a drying room and a painting room, where they are painted with basic colour and then necessary data in different languages is printed on them until the final check point is reached.
- This lasts maximally 10 minutes. Because it is expensive to adjust the machines for another product with different dimensions and different inscriptions, large batches are manufactured.
- After a quality control checks, tins are put on palettes and sent to a warehouse, where they stay usually 4 weeks.

- From the warehouse tins are sent to a filling facility. Firstly, they are washed and then filled with Coca-Cola, sealed with a lid by the cover lid, marked with the production date, packed into boxes, (9 tins into one box), palletized and sent to the central warehouse, which supplies all of Great Britain. Tins are here for at about 5 weeks, then are sent to the regional distribution warehouses of Tesco in Britain.

- In Tesco warehouses palettes stay 3 days and then during the night they are distributed into individual stocks in Tesco shops and during 3 days they are sold.

- When we buy a tin of Coca Cola, we stock it at home again for some days. Then it is consumed, which demands cca 5 minutes.

- According to older data, only 16 percent of empty tins are sent to Norway to be recycled. In a theoretical case of 100 percent recycling, there could be small smelting equipment with small rolling mills, located close to a production plant for tins in Great Britain, which would eliminate much wasted time [transport, storing].

Table 6.2 Value flow for 1 box of Coca-Cola

	Storage of inputs	Processing time	Storage of outputs	Production batch	Cumulative days	Waste %
Mine	0	20 min	2 weeks	1000 t/h	319	0
Establishment for reduction	2 weeks	30 min	2 weeks	--	305	0
Smelting mill	3 months	2 hours	2 weeks	---	277	2
Hot rolling mill	2 weeks	1 min	4 weeks	3m/min	173	4
Cold rolling mill	2 weeks	1 min	4 weeks	700 m/min	131	6
Manufacturing of tins	2 weeks	1 min	4 weeks	2000/min	89	20
Filling	4 days	1 min	5 weeks	1500/min	47	24
Tesco/distribution [stock]	0	0	3 days	--	8	24
Tesco – shops	0	0	2 days	--	5	24
Storing at home	3 days	5 min	--	--	3	?
Total	5 months	3 hours	6 months	--	319	24

Questions

1. Can the principles of effective material flow be used also for example on people moving in services or not?
2. When is it better to use transport of materials in big batches and when in small batches? Give reasons.
3. Material flow at the workplace has 4 basic arrangements. Which arrangement has a tendency to shorten and which to lengthen the flow?
4. The effective material flow should not stop, or only for a very short time. Which methods help us to reach this objective?
5. Present at least three indicators which characterize the material flow.

7 Information flow

Chapter objectives

- Information is the most important source of human activities. Our body gives us information that we have hunger or thirst, if we are sick or OK and many others, but we receive much more information from our environment, that is from nature or society.
- Manufacturing also needs information, what and how much to produce, what could be the future tendencies, what is the situation at our competitors. But the decisive role here has the consumer; his wishes and possibilities.
- Necessary information must be in the firm promptly processed and distributed to adequate formations which can use it. On the other hand, there must also be a system of reverse information from departments to a central computer (department) which can evaluate the situation and recommend to TOP management, where and what actions to take for improvement.
- The development of information systems, processing of information and transferring it to responsible managers, made in last few years big progress.

7.1 Information flow – introduction

Information – a new finding about a certain event contained in a message which has the character of a statement (verdict). That means we can say whether it is truthful or untruthful.

Information system – a set of people, technical devices and methods providing the collection, processing, maintaining and transfer of data for the creation and presentation of information according to the needs of active users in a management system.

Logistic information systems provide information which is necessary in logistics. This is the basic tool for the management of logistic processes in real time and in cooperation with other information systems.

Requirements of information systems
The objective: to harmonize business objectives with the necessary demands on information.
Partial objective: to enable continuous material flow.

Parts of information flow

HARDWARE (technical devices), HW = computer systems of different sorts and sizes, which are connected by means of a computer network. To this also supporting technologies belongs (bar codes, RFID).

SOFTWARE, SW = necessary programs.

ORGWARE, OW (organizational tools) = a set of regulations, how to operate and use information systems and information technologies.

PEOPLEWARE, PW (human part) = effective operating of people in computer environment.

DATAWARE, DW – necessary data.

The importance of individual parts of information system is (from less to most important).

HW + SW + DW + PW + OW

Information technology
It is a tool for processing data.

At the present time the difference between information systems and information technologies is blending, the abbreviation IS/IT has been introduced that expresses it. Often the abbreviation IS/ICT is used that accents the growing importance of communication technologies.

Logistic information system (LIS)
It provides the data and algorithm necessary for the effective management of the flow of goods.

LIS must include all three levels of management: strategic, tactic and operatives.

LIS must include the complex logistic chain from supply, through production to the delivery of goods to customers and display all changes in real time, if possible.

At the same time LIS must provide information about costs in the individual parts of the whole logistic chain.

Parts of logistic information system
Material subsystem
Managerial subsystem: planning and scheduling, organizing, coordination, information, decision taking, performing and controlling of strategic, tactical and operative logistic activities.

Information subsystem: selection, receiving, processing, control, maintaining and transfer of data to necessary places (locations) in demanded structure and demanded time in the form of information needed to make decisions.

Communication subsystem – transmission of data to necessary location.

LIS CLASSIFICATION according to the ORIENTATION of information flow
Upstream: starting from the clients' order, to processing the order until ordering the necessary raw materials (parts, items) for manufacturing.

Double – faced flow – necessary for systems MRP-1, Kanban, Just-in-time, operation planning. Information flow heads upstream and downstream, as necessary, but it is oriented only on production.

Downstream: for example a letter or advice for the customer, when work-in-process phase of the product will be delayed or delivered earlier.

Similar information is sent to the carrier (transport operator) to be prepared for delivery. Then follows information concerning receipt of the product and the invoice.

In some cases information flows still between the client and producer concerning warranty claims and replacement.

Necessary information
Information should be accessible from computer networks.

But there will always also be such information which can be obtained only through personal contact, at conferences, in different mediums or such which is obtained from different consultancy firms and must be purchased for money. Information has not only a structural form of a table, formula, it can have the form of:

- Information concerning the environ of the firm.
- Information about intradepartmental processes.

The value of information decreases over time.

Information must be provided to all employees but always only such information, which is for them necessary.

TRENDS in IS/ITS

- Communication among business partners changes. Instead of written documents, there now exists electronic data interchange (EDI).
- Changes in form of product and service sales (home shopping), on-line banking services for clients (home banking) etc. All this represents advantages for customers:
  - Prompt reaction,
  - Services 24 hours daily, 7 days in the week,
  - Automatic selection of the best supplier.

Electronic money payment reinforcement
Some benefits of IS/IT

- Acceleration of the business cycle; that is the time from accepting the order until delivery of goods to client.
- Creating fixed bindings among business partners.
- Application of modern delivery methods (JIT, PULL).
- Accelerating of payments contact with the bank.
- Improved possibility to follow (watch) cash-flow.
- Inventory reduction – both of materials and finished goods.
- Reduction of work-in-process production.
- Improving quality of goods and services.

Economic advantage which the firm can obtain by means of new information technologies increases permanently, but the time of using the competitive advantage is every year shortened.

7.2 System EDI and its role in information flow

EDI – Electronic Data Interchange is the way of communication between two independent subjects, when documents in standardized and structured form and also other documents are interchanged electronically.

EDI is the transfer of structured data by agreed message standards, from one computer system to another without human intervention. By adhering to the same standard, two different companies even in different countries can electroni-

cally exchange documents (such as purchase orders, invoices, shipping notices and many others).

Formerly, when a company wanted to buy something, it typically had to generate a description of the products, a purchase order, order confirmation, contract terms, shipping papers, financial arrangements, delivery details, special conditions, invoices and so on. In the past, all of these and mountains of other paperwork had to be printed and posted between organisations. EDI has simplified this work.

EDI has existed for more than 30 years and there are many EDI standards, some of which address the needs of specific industries or regions.

The EDI standard prescribes mandatory and optional information for a particular document and gives the rules for the structure of the document. The standards are like the building codes. Just as two kitchen can be built "to code" completely differently, two EDI documents can follow the same standard and contain different sets of information. For example, a food company may indicate a product's expiration data while a clothing manufacturer would chose to send colour and size information.

However, EDI is not confined just to business data related to trade but encompasses all fields such as medicine (patient records and laboratory results), transport (container and modal information), engineering and construction etc.

EDI documents generally contain the same information that would normally be found in paper documents used for the same organisational function, such as:

- Invoice address,
- List of production numbers,
- Quantity,
- Purchase order and acknowledgement,
- Invoice,
- Payment address.

One very important advantage of EDI over paper documents is the speed in which the trading partner receives and incorporates the information into its system, thus greatly reducing the cycle time. For this reason, EDI can be an important component of Just-in-time production systems.

EDIFACT – general and inter-branch standard
EDIFACT contains different types of news:
In the Czech Republic the most broad are following types of news:

- ORDERS – orders
- INVOIC – invoice
- COMDIS – business objection (conforming or refusing the invoice)
- INVRPT – inventory overview
- DESADV – letter of advice – sent goods
- PRICAT – catalogue of goods and prices.

Why to introduce EDI?
EDI is supported by most big retailer's supply chains.
EDI is necessary for communication with partners abroad.

Easy accessibility of suitable EDI solutions and services minimizes financial and technical demands for devices and operation of EDI and increases the reliability of this way of communication.

Main advantages of EDI

- EDI provides important savings of long-term costs.
- It decreases costs of postage, print, evidence.
- It decreases costs of administrative workers (clerical staff).
- It saves time, accelerates circulation of documents.
- It simplifies transfer of documents and their archiving.
- It reduces the error rate in comparison with manually inserting data.
- It increases safety of transferred documents.
- It makes possible uniform communication of different systems and subjects.
- It contributes to more effective planning and management of business.

7.3 Bar codes

A bar code is a number (digital) in a form suitable for reading by machines.

The most widely used technique in warehousing is bar-coding, which represents numbers and letters in printed form and is machine-readable by appropriate scanning equipment. It is a fast and accurate technology. There are various different bar-code types. In warehousing, bar coding is used to identify goods and veri-

fy stock location. It allows goods to be sorted and controlled through a handling system and enables them to be tracked as they move through the system. It simplifies stock checking and many other data inputs and capture requirements. Barcode labels are cheap, although they can be damaged by scuffing, and the technology is established, reliable and fast. Normal bar codes can only provide a few digits of data, such as a product code or a pallet identification code.

Figure 7.1 Examples of Bar code (Pernica, 1994)

Figure 7.2 Example of Bar codes (own source)

European Article Numbering (EAN)
One dimensional Bar code
This code is used in Europe. In Canada and the USA the UPC code is used.

EAN code is divided into two parts – the left and the right. In the middle there are two very thin lines. Similarly, at the beginning and the end of the code there are used starting and finishing characteristics with two thin lines.

The first three numbers indicate the country – for example 859 = The Czech Republic.
Next four numbers indicate the producer.
Next five numbers are reserved for the product number.
The last digit at the right side is a control digit.
So in the Czech Republic EAN can be used by up to 9999 users and each of them can use it for 99 999 different products.

There are also two-dimensional bar codes available and, as the name suggests, they are scanned in two directions simultaneously. These can hold hundreds of numbers but their use is not widespread, as special scanners are required at each stage in the supply chain and common standards are not fully established.

Figure 7.3 Two dimensional bar-code

Aztec Code

Designed by Andrew Longacre at Welch Allyn (now Honeywell Scanning and Mobility). Public domain. – International Standard ISO/IEC 24778

7.4 RFID – radio frequency identification of data

RFID is the wireless use of electromagnetic fields to transfer data for the purpose of automatically identifying and tracking tags attached to objects.

RFID – Radio Frequency Identification of Data
Accelerates information flow – automatic inserting of data instead of using bar codes.

Parts of RFID:

1. Transponder, TAG – system for storing data that is located on the unit of goods.

2. Facility, which can scan or write necessary information, so called reading (writing) facility.

TAG
Tag is placed on the object (unit) and data are scanned always when this unit enters into the system or leaves it. In Tag memory there are thoused data such as owner´s code, serial number, dimensions or weight of the unit etc.
Tag consists of fourth components:
1. Microchip, 2. Antenna, 3.Carrier (pad), 4. Battery (only for active Tags).

Passive and active TAGs
On an underlying material a layer of anode is applied. Then a thin layer to separate it is applied. On this a polymeric cathode is printed. So a flat LiPol battery is created, on which the foil with microchip and antenna is applied. So an etiquette (label) is established, which is maximally 1 mm thick.

The most modern transponder is called as **Smart Label**.
The microchip is integrated as a complex together with the antenna on the plastic foil which has a thickness of only 0.3 mm. Smart Labels can be delivered as printed on rolls, labelling can be realized automatically.

Figure 7.4 The TAG

Three main groups of Tags:

1. **Active TAGs** have a battery and can periodically transmit their Information data signal (data about different emissions, temperature in towns etc.).

2. **Battery assisted passive Tags** – have a small battery on board and are activated when they are in the presence of an RFID reader, which emits radio waves. They contain more information and new information can be added (Tag on the vehicles which periodically visit the warehouse). RFID Tags can be read at a distance, to allow entrance to controlled areas without having to stop the vehicle and present a card or enter an access code.

3. **Passive TAGs** – have no battery, are cheaper and smaller. Instead the Tag uses radio energy transmitted by the reader. This tag can only be read – it has a factory – assigned serial number that is used as a key into the database.

Tags may be embedded in or on the tracked object, for example a car, computer, book, phone etc. Tag can be read if passed near the reader, even if it is covered by an object or not visible.

Champion Chip
RFID for timing races. In the race, the racers wear tags that are read by antennae placed alongside the track or on mats across the track. UHF tags provide accurate readings with specially designed antennas.

Figure 7.5 The TAG for sports

RFID UHF antenna Iron Time

Practical use of tags:

- Attach an RFID tag to a work-in-process part on the assembly line and track the progress through the assembly line.
- Livestock and pets may have tags injected, allowing positive identification of the animal.
- Tags can be used in inventory systems.
- Tags can also be placed on vehicles which can be read at a distance, to allow entrance to controlled areas without having to stop the vehicle and present a card or enter an access code.
- In many countries RFID tags can be used to pay for mass transit fares on bus, trains, or subways, or to collect tolls on highways.
- Tags are used in sport.

7.5 Central information system in the enterprise

In an organisation with functional management, individual departments are isolated and do not know what happens downstream or upstream.

Example:
The store needs a new delivery of items, so it informs the purchase department to ensure it. But how can the top accountant know if goods were already delivered and whether the invoice should be paid?

Consequences:

- Big amount of paper documents circulating among departments.
- Errors in documents.
- Time delays.
- Increase of inventory.
- Bad visibility of processes, back information is missing. Every department has its own information system on how to create and send paper documents.

Management in integrated organisation (process management)
All information goes into a central computer system where it is processed and always only a part of it is distributed to individual departments. Backward information from departments goes back to the central computer and is provided to others according to their needs.
This is made by the SAP system.

- Business department receives client's order and insert it into firm's information system and confirms the delivery of goods.
- The storeroom is informed immediately.
- After sending goods to the client, the accounting department is informed automatically that the invoice should be sent.

SAP – the first fully integrated system
1972 – Five former employees of IBM founded in Germany their own firm.

The aim: to develop software application for firm's processes in real time.
1980 – This firm had already become a successful firm.

- First product was SAP/R1 (real data processing),
- SAP/R2 follows,
- SAP/R3 follows, later SAP CRM and others.

The company has 50 thousand employees in 120 countries around the world. SAP has been translated into 33 languages and adjusted for 25 main industry branches. SAP is the third largest seller of software, just behind Microsoft and Oracle.

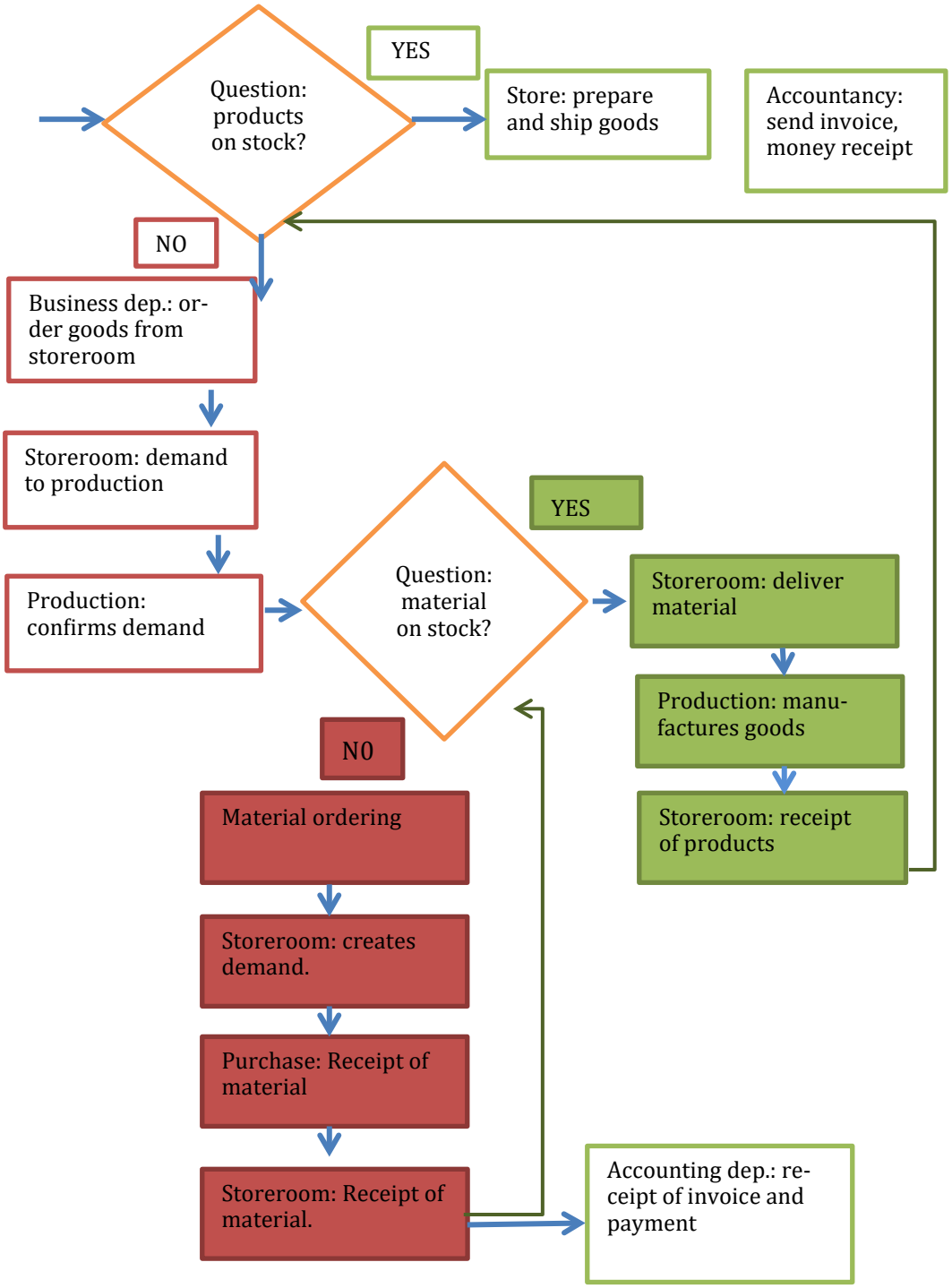
7.6 Example of integrated process

Simple process – if ordered goods are in the storeroom and the order can be simply realized.

If goods are not in the storeroom, the process of order realization has to be interrupted. There exists a checkpoint (inventory control) and a decision has to be made. If there is sufficient inventory, the process can continue.

If there is not a sufficient quantity of inventory to fulfil the order, it is necessary to continue on another branch (see picture 7.6).

Figure 7.6 Integrated process



Questions

1. What is the role of a Logistic system in the firm?
2. Explain the principles of the EDI system.
3. What is the difference between one and two-dimensional Bar-code?
4. Explain the principle of RFID and its use in manufacturing.
5. What are the components of the TAG and which different TAGs do we distinguish?
6. Is it better to have in the firm a central information system or more local systems?

8 Theory of constraints, TOC

Chapter objectives

- Imperfection of commonly used methods of management (MRP-I, MRP-II, ERP and others) is mostly the following:
- Orientation primarily on the solution of partial problems, not systematic solution.
- Absolute majority of management systems is oriented only on planning. Real management is left to individual decisions of workers at local level.
- To most elements of production process deterministic character is assigned, but in reality they have stochastic character.
- Majority of occurrences in manufacturing processes are mutually interdependent and so an isolated solution of chosen parts cannot bring any successful change.

Among the new concepts of management, also belongs Theory of constraints, TOC.

8.1 Groups and areas of constraints

The theory of constraints (TOC) was introduced by Eliyahu M. Goldratt in 1984 in the book The Goal.

A constraint is anything that prevents the system from achieving its goal. There is at least one but at most only a few constraints in any given system. Constraints can be internal and external.

Two basic groups of constraints:

- Material constraints – connected, for example, to the capacity of machines, tools, measuring apparatus.

- Non-material constraints – for example, demand for a product, forms of regulations and proceedings, information of firm's environment etc.

According to experience, the majority of contemporary constraints have a non-material character and concern the firm's culture.

The constraint is the limiting factor that is preventing the organization from getting more throughput (typically revenue through sales), even when nothing goes wrong.
Types of internal constraints:

- Equipment: The way that the capacity of equipment is currently used or if the capacity is insufficient.
- People: Lack of skilled people limits the system. Mental models held by people can cause behaviour that becomes a constraint.
- Policy: a written or unwritten policy prevents the system from making more.

Table 8.1 Specific types of internal constraints and their impact

	Constraint	Throughput
Production	Machine-capacity limit	Quantity of manufactured units
Firm	Special department in the firm	Quantity of sold products or services
Supply chain	Level of services, laws, firm's culture etc.	Quantity of satisfied customers

Basic key areas of Theory of constraints (TOC)
Every real system includes at minimum one limited place – the constraint.

If there would not be such limited place (element, constraint), then the system (firm) would reach its goals with unlimited speed and in unlimited quantity.

If a constraint prevents the manager from reaching higher levels of his goals, then he must manage this constraint.

There are two possibilities: either we manage the constraints or the constraints manage us.

Theory of constraints and the supply chain
To strengthen other links in the chain than the weakest link makes no sense. But after removing the weakest link (reinforcing it) there appears limitations in some other link and so the process of strengthening the weakest link never finishes.

8.2 Drum – buffer – rope

Drum – buffer – rope is a manufacturing execution methodology, named for its three components.

The Drum is the physical constraint of the plant: the work centre, machine or operation that limits the ability of the entire system to produce more. The rest of the plant follows the beat of the drum. They make sure the drum has work and that anything the drum has processed does not get wasted.

Drum dictates the production rhythm, similarly, as the drum gives the tact in marching music. No more products than the weakest link allows can be produced. There is no sense in sending into production more or less materials than the weakest link can process.

The BUFFER protects the drum, so it always has work flowing into it. Drum must perform at 100%, non-stop. Every minute lost in the weakest link of the system cannot be compensated for in other links of the system. Every hour saved on another place than in the weakest link has no economic importance.

This weak, narrow link must be protected against starving by a suitable dimensioned buffer (here: inventories). There is a difference in comparison with the system Just-in-time or MRP, which do not "work" with inventories.

ROPE
It is important to estimate (based on experience) the time needed to deliver material from its storing place to the weakest link in the chain. This time is called "ROPE", because rope pulls inventories. The rope must be long enough (enough time) and work so that the buffer after it will not be either empty or overfilled.

Table 8.2 Performance of the firm and used metrics

Financial indicators		
Net profit	ROI (Return of investment)	Cash-flow
Operative indicators		
Throughput	Inventory	Operating costs

Throughput – money which enters into the firm
Inventory – money which is in the firm
Operating costs – money needed to transform inventory into throughput

LIMITS to increasing the throughput
The capacity to receive much money by means of inventory and operating costs is theoretically limited by their zero value.
But the possibility to gain much money through greater throughput is in practice not limited.

8.3 Application of TOC

STEPS in applying Theory of constraints.

- Become aware of the aim of the organization. Usually, it is to make money now and also in the future.
- Identify the weakest link in the firm.
- Maximally utilize this weak link to increase throughput.
- Subordinate all other processes to this weak link.
- Improve the weak link – extend the borders for limited capacity.
- If you succeed in removing constraints, then return to point 2 and repeat the whole procedure (find a new weak link which originated through removing the previous weakest link).

WHAT CAN PRODUCTION EXPECT FROM INTRODUCING TOC ?

- Substantial inventory reduction because the throughput will increase.
- Easier planning than using MRP and better control than in Just-in-time system.
- Better foresight of production proces.
- Possibility to concentrate on improving process only there, where it brings real effects, including directing investment to this location.

Up to now, fluent material flow in the chain has been assumed and the role of managers has been to remove barriers that limit this flow.

TOC emphasizes different performances of individual links and to manage throughput in the weakest link.

It is necessary to maintain in front of the weakest link sufficient inventory of material input so, that this link will never starve because of a lack of materials (Buffer).

It is necessary to monitor the time needed to deliver material to the weakest link (Rope) and, according to the performance of this link, to put at the beginning of the Supply chain, new material into production.

Questions

1. What are material and non-material constraints? Give some examples.
2. Explain the different views on stocks in Just-in-time system and TOC system.
3. How long must the “Rope” be in the Drum-Buffer-Rope system?
4. How many constraints can be in every system?
5. When managers eliminate the constraint in the system, can the firm produce goods without any constraints?

9 Reverse logistics and waste management

Chapter objectives

- Reverse logistics tries to return products into a new use after their life-time cycle, or at least to be used in some way their components or materials.
- This is because resources of raw materials are decreasing and the price of these materials are increasing substantially.
- The second reason is for the care of the environment, where different goods after their life-cycle cannot be stocked in landfills, but their components must be effectively used.

9.1 Origin and importance of reverse logistics

THE ROOTS OF REVERSE LOGISTICS (RL)
Reverse logistics is defined as the flow of used products, packages, (wrappings) and other materials, which come from the customers.

Other definition:
The main contents of RL is the collection, sorting, dismantling and processing of used products, subsidiary products, redundant inventories – wrapping materials, where the main objective is to secure their new utilization or material revaluation in such way that is careful to the environment and is in an economic interest.

Small differences in RL definition come out of specific industry branches, with which RL is connected. For example, in retail trade the greatest importance is given on shifting non sold goods and specific goods back to subjects, where they were purchased.

THE AREA OF REVERSE LOGISTICS
Reverse flows take origin from the customers. These are flows of spoiled, depreciated or morally obsoleted products, goods with expired durability, seasonal goods, wrappings and claimed goods. These flows are usually uneconomical with

regard to bad organization. From the view of society, they usually have a negative influence on environment.

WASTE LOGISTICS
Besides reverse logistics there also exists "waste logistics". Its main task is the highest material or energetics use with a minimum of waste disposal (on landfills).

THE MAIN OBJECTIVE OF REVERSE LOGISTICS
The main objective is to ensure the new use of waste materials (products) or only a material use (recycling) in a way which is careful to the environment and is economically advantageous.

Also materials, which are today for reverse logistics not attractive, can, in the future by means of improved technological processes, increase their value and so become a part of reverse flows (waste uranium fuel from atom power stations).

GREEN LOGISTICS (Ecological logistics)

- It studies and minimizes the impacts of logistics on the environment.
- It measures the influence of real impacts of transport on the environment.
- It tries to decrease the material and energetic demands of different logistic activities, starting from designing the product.
- It has a connection to certification according to the ISO 14000 standards. But there exist also some activities of green logistics that have no relation to reverse logistics, for example, an effort to decrease the energy consumption, etc.

REASONS FOR A BIG BOOM OF REVERSE LOGISTICS
Internet shopping
Increased interest of reverse flow management has been caused by the expansion of internet shops, because there return of products is multiple in relation to "stone shops". Return of goods in particular branches in the USA was at the beginning of 21th century: printed magazines 50%, books 25%, electronics 10–20%, goods of mass production 10%, cars 5%.

Ecology
Ecological initiatives push upon enterprises to be engaged more with the problems of reverse logistics. The same effect also has the rising charges of waste disposal in landfills. Producers can be forced into more ecological behaviour by means of two ways:

Ecostrategy PUSH

- Approving laws concerning the environment.
- Protests of citizen activities.
- Regulations of demands for receiving credits.
- Ecological consciousness of employees.
- Ecological behaviour of competitors.

Ecostrategy PULL

- Ecological consciousness of customers.
- Wishes of customers, shopkeepers.
- Programs of subsidies for ecological activities.
- Awarding firms with state or regional diplomas for ecological behaviour.

But this second strategy has not had such penetrating results as the first.

9.2 Technique to improve management in reverse logistics

1. Set objectives and strategies (impacts, costs), for reverse logistics.
2. Figure out the best way to "extract" value from reverse materials.
3. Evaluate the surroundings of the firm – legislature, environmental impacts, ability and limits of partners in the SC.
4. To prepare the system of proceedings, preventing the origin of reverse flows, inspection of waste materials and their sorting for processing.
5. To prepare reverse webs, define possibilities of flows is such webs, decide the forms of material transport.
6. Propose new financial regulations-methods how to appreciate returned materials regulations for granting credits.
7. To find and investigate potential markets. Set rules for their use.
8. Propose metrics and set target values. Appreciate performance of reverse logistics in relation to the whole enterprise performance.

9. Develop new products with low material demands, which can be simply dismantled.

INTEGRATED PRODUCTION POLICY

It is necessary to review products from the view of their whole life time cycle, from obtaining raw materials, their manufacturing, distribution, using and waste material treatment. Such products must be supported, that:

- Will have from the whole life cycle the lowest negative influence on the environment.
- Will demand the lowest consumption of materials and energy.
- Will not contain substances that harm health and the environment.
- Will be manufactured (if possible) with recycled materials.
- Will be used repetitively and simply recycled.
- Will produce the lowest amount of waste with negative substances on health and the environment.

Return takeover of products

Return takeover of products comes out of the individual producers' responsibility to deal with products after their life cycle. The aim is to motivate producers to design and produce products with the lowest volume of hazardous substances, but so that their following removal after the finishing of the life time cycle will be simple and cheap.

Final users of products must be informed, how and where it is possible to hand over products with a finished life cycle and be motivated to separate collection of such waste. The reverse takeover concerns:

- Old and damaged cars,
- Batteries, accumulators,
- Electronics,
- Wrappings, packaging,
- Tyres and oils,
- Solar panels.

Analysis of reverse logistic processes
In reverse logistics these elements are present:

- Used products after their life time cycle.
- Waste from manufacturing.
- Goods returned from shops (claims of consumers).

Demanded attributes of returned goods, their collection and processing:

- Effortless disassembly.
- Homogeneity of individual elements (material clearness of elements) entering recycling.
- Information of hazardous substances (for example in batteries).
- Easy transport, for example, transport combination with new products in distribution returning old (returnable) wrappings.

The more these attributes are demanded, the higher the costs of collection are.

COLLECTION – income control – gate-keeping
Income control reviews products and materials before their entering into next activities of reverse logistics. Different issues should be solved:

- Does the client returns the product from our production or sale?
- Has the product any warranty time?
- Has the material demanded structure of components?

Employees must know exactly, which products they can accept and of which parts must the returned product consist of.

Table 9.1 The most usual reasons for returning products

CLIENTS	RETAIL
The product does not fulfil the client's demand	Expired guarantee time
The client does not know how to treat with the product	Seasonal product
The product was defective	Product was replaced by a new version
The client misuse the liberal warranty policy	Sales of the product has been stopped
	High level of inventory of this product
	Salesman business activity has finished

Collection
There exist three basic ways:

1. Client returns goods directly to the producer (for example, copy techniques). Customer motivation: price discounts when also buying a new product.

2. The salesman collects products and sells them to the producer.

3. Products are collected by an independent subject which sells them to the producer (car industry) or to mother processing plants. This is represented, for example, by "collection yards" in cities, to which citizens deliver their old products.

Table 9.2 Ways of treating with returned goods and raw materials

PRODUCTS	WRAPPINGS
Return to supplier	Reuse – bottles of beer
Basic repair	Recycling
Rework	Deposing in landfills
Dismantling	
Recycling	
Deposing on landfills	

The main objective is to receive the greatest value from returned materials and depose on landfills only the minimum possible (it is very expensive).

PROCESSING OF WASTE MATERIALS
DIRECT REUSE – without any previous adjustment, usually only after cleaning (returnable bottles of beer) or repacking.

REPAIR – demanded products are repaired and can provide their original function. But the number of repairs will decrease in the future; purchasing a new product will be cheaper in comparison to the repair.

RECYCLING – The product or its parts are dismantled into original materials, which are again used after next processing. This way saves not only renewable sources of raw materials but often also decreases the load on environment. But recycled materials often have lower quality than primary materials (higher percentage of admissions - paper).

REMANUFACTURING
Demands much labour. The product must be dismantled to small parts, which must be controlled. Defective or worn-out parts are replaced by new ones. The finished product consists then of new and old parts, is fully comparable with a new one, but the client must have no interest in it because of these old parts.

UPGRADING
It is a similar process as repair but the finished product receives also some new functions and so it has a newer quality and value than the old (aircraft, or some military techniques).

CANIBALISM
One or more parts of the product, that are no longer used, are dismantled and used to repair another product. The original product becomes continually non repairable.

Subjects for recycling

1. The primary producer. Advantage: direct relation; the firm can flexibly adjust construction of manufactured products using knowledge received in recycling and dismantling. Disadvantages: new firm must have recycling technology.
2. Consortium of producers – some producers found a consortium which takes over responsibility for remanufacturing. Costs decrease but there must be more places for collecting and dismantling.
3. Specialized company. The producer can transfer the responsibility of processing to a foreign subject.

Questions

1. Why do we speak about Reverse logistics now and not 50–70 years ago?
2. What is the difference between reverse and green logistics?
3. Why is PULL ecostrategy less successful than PUSH strategy?
4. What special products make up the main contents of reverse logistics?
5. Why do people use repairs of products less than some decades ago?
6. Introduce a product, where upgrading is usually necessary and economically advantageous.
7. Recycling – how and where it is used on the international Orbit Spatial Station?

10 Waste management

Chapter objectives

- Waste consists of objects and materials, which people discard or intent to discard.
- During the last centuries people settled more in big cities that makes permanently big problems with industrial and municipal waste.
- Now the tendency prevails, to terminate with depositing municipal waste in landfills, restrict incineration and concentrate on the recycling of these waste.
- Special handling of some products after their life-time is needed for cars, tires, refrigerators and others.

10.1 History of waste management

Waste produced during pre-modern time was mainly ashes and human biodegradable waste and these were released back into the ground locally, with minimum environmental impact. But when there were more people in small locations, the situation changed. Much rubbish was thrown away from households on streets that then remained sinks, cesspools. Consequences were fatal: illnesses and bad environment.

The consequence between hygiene of environment and diseases threatening the health can be clearly proved in less developed countries. Everywhere where rivers serve to remove waste, where people are rummaging through dumps of garbage to find at least something to sell, where clearance after natural or military disasters is not possible, there overall expanded connected diseases.

A breakdown started in the second half of the eighteenth century by means of doctors and scientists, as Semmelweis, Pasteur, Koch etc., who proved that viruses and bacterium cause illnesses which expanded mainly due to bad hygiene. Engineers and technicians were required to help cities with these issues.

Calls for the establishment of a municipal authority with waste removal powers were realized in London in 1751. It was declared that preservation of the health of the people is of great importance and that the cleaning of the city should be placed on public management.

Firstly, the waste of cities was removed behind the cities for disposal in landfills. But the dramatic increase of waste for disposal led to the creation of the first incineration plants.

Similar municipality systems of waste disposal sprung up at the turn of the 20th century in many large cities in Europe and North America. At the turn of 19th and 20th centuries, recycling of home garbage was put into practice. The first manual sorting establishment was built in the USA in 1898, where 37% of original garbage was recycled.

Modern waste management in Europe and in our country too, has its origin after the II. World War. There were several reasons for it:

1. Environmental consciousness of people.
2. Decreasing volume of primary natural resources.
3. Better economic situation of people, which consumed more goods and as a consequence also more waste materials produced.

10.2 Waste definitions

Waste consists of substances or objects which are disposed or are intended to be disposed of or are required to be disposed of by the provisions of natural laws.

Waste consists of materials that are not prime products (not produced for the market), for which the first user has no further use in terms of his own purposes of production, transportation or consumption, and of which he wants to dispose.

Wastes may be generated during the extraction of raw materials, their processing, the consumption of final products and other human activities.

EU definition: Waste is an object the holder discards, intents to discard or required to discard.

Hazardous waste is waste that is registered in the list of dangerous waste.

Waste handling is their gathering (collection), sorting, transporting, storing, adjusting, using and removing.

Ways of waste handling are divided into 2 groups:

1. Exploitation of waste – activities are enlisted in the Supplement No. 3 to the law 185/2001 Sb.
2. Removing of waste – activities are enlisted in the Supplement No. 4 of the same law.

NEGATIVE ASPECTS OF WASTE

- Higher costs to sustain kindly environment.
- Extent of diseases from "wild" landfills.
- Water, soil pollution, origin of methane (greenhouse gas).
- Shifting wastes to less developed countries.
- Rummaging in landfills and looking for what can still be sold – in less developed countries.

THE ECONOMIC COSTS OF MANAGING WASTE are high and are often paid for by municipal governments. Money can often be saved with more efficiency designed collection, routes, modifying vehicles and with public education.

Environmental policies such as "pay as you throw" can reduce the costs of management and reduce waste quantities. Waste recovery (that is recycling, reuse) can curb economic costs because it avoids extracting raw materials and often cuts transportation costs.

10.3 Basic principles of waste management

1. WASTE HIERARCHY

It refers to the "3Rs" principle: REDUCE, REUSE, RECYCLE, which classify waste management strategies according to their desirability in terms of waste minimization. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

1.1. PREVENTION. The waste hierarchy is represented as a pyramid because the basic premise is for policy to take actions first and prevent the generation of waste.

1.2. REDUCTION, MINIMALISATION. The next step of preferred action is to reduce the generation of waste.

1.3. REUSE (ex.: beer bottles).

1.4. RECYCLE (ex.: old paper).

1.5. ENERGY RECOVERY: Waste-to-energy, incineration.

1.6. DISPOSAL in landfills or through incineration without energy recovery.

2. LIFE- CYCLE OF A PRODUCT

It begins with design, then proceeds through manufacture, distribution, use and then follows through the waste hierarchy stages of reuse, recovery, recycling and disposal. Each of the above stages of the life-cycle offers opportunities for policy intervention, to rethink the need for the product, to redesign it, to minimize waste potential, to extend its use. The key behind the life-cycle of a product is to optimize the use of the worlds' limited resources by avoiding the unnecessary generation of waste.

RESOURCE EFFICIENCY
The current, global economic growth and development cannot be sustained with the current production and consumption patterns. Globally, we are extracting more resources to produce goods than the planet can replenish. Resource efficiency is the reduction of the environmental impact from the production and consumption of these goods, from final raw material extraction to last use and disposal. This process of resource efficiency can address sustainability.

PRODUCTION OF WASTE – CZECH REPUBLIC 2012
Total production made 23.4 m. tonnes of waste; from this was made hazardous waste 6%.

From the total amount of waste, 19.9 m. tonnes were produced by enterprises, and the larger part of the rest was municipal waste, that is at about 307 kg/year/person (3.2 m. tonnes.). Of the total quantity of industrial waste, mostly the biggest enterprises took part.

Waste is also an important export or import article.
In 2012, to the Czech Republic was exported 0.8 m tonnes of waste, exports made 2.8 m. t. Exports were mostly iron from building activities, paper, packages, metallic of car wreckages.

MUNICIPAL WASTE
In 2012, in the Czech Republic was made 3.2 m tonnes, that is 307 kg/person (daily average closely to 1 kg/person). Comparing with the other EU states, our republic has a very low amount of waste.

Each inhabitant sorted from this 307 kg in average, 43 kg of waste, from this:

Paper	14 kg
Glass	11 kg
Plastics	10 kg
Metals	4 kg
Others	4 kg

On average, in EU states is made municipal waste of 520 kg/person/year.

It is difficult to compare the quantity of waste among countries; they have different definitions and statistics of waste.
For example, in 2001, the Basel convention estimated waste in Europe of 338 m. tonnes, but OECD estimated it at 4 billion tonnes. It is better to compare only a tendency of a time series or a percentage of different kinds of waste.

ISO STANDARDS
Management of waste is a key problem in the effort to reach the ISO 14 001 standard. Enterprises are supported to make their environment effective through removing wastes and returning it into production by means of recycling. It is necessary to shift the effort from single deposit waste in landfills to recycling.

THE LAW OF WASTE
Selecting waste must be simple.
Municipalities must make it possible for citizens to select basic secondary raw materials, such as paper, plastics and beverage containers. Starting in 2015, the collection of biodegradable materials must be organized also. Here, in particular, big resources and the amount of materials deposited in landfills should be decreased.
Every municipality should calculate the charge for waste of two parts:

- The fixed part (up to 250 CZK/person) and
- The variable part (according to the real quantity of not sorted material – up to 750 CZK/person and year).

10.4 Municipal waste

It represents all waste that originates from physical persons activity in the community area. According to the law, initiator of this waste is the community. Community waste contains: mixed community waste, separately collected components (paper, plastics, glass, beverage containers, hazardous waste, bulky waste (furniture, carpets, tires...), garden waste etc.

Self-employed person's waste: it is similar to community waste and it originates in activities of physical persons or legal persons with a small volume of perfor-

mance in their business activities. This waste becomes a part of community waste and is regularly handled in the community system.

SEPARATION OF MUNICIPAL WASTE
Before recycling, waste must be sorted according to different kinds of materials. This usually increases costs and so it is advantageous when waste is sorted directly in households which deposit them into different containers.

Table 10.1

White glass	White containers
Coloured glass	Coloured containers (green)
Plastics	Yellow containers
Paper	Blue containers
Electro materials	Red containers
Beverages	Orange containers
Biodegradable waste (waste of vegetable, grass of parks, gardens)	Brown containers

Besides this, there still exist containers on mixed waste (black colour), their contents are later directly deposited in landfills. But deposing waste in landfills must terminate in 2024.

Metal, aluminium and copper are purchased by special firms. Relative simple recycling is when waste contains only one sort of material. Therefore, it is better when different containers for metal wastes exist.

WASTE HANDLING AND DEPOSIT
To deposit waste is continually more expensive because there are many demands on landfills from the environmental policy.

- It should not let water penetrate through it – danger of water resources pollution.
- Material on the deposit must be compacted (less volume).
- Finished landfill must be covered by clay or by a special textile material (to prevent access of rodents or wind destruction.

Eastern states of Europe (Bulgaria, Greece.ect.) deposit more waste in landfills, Western Europe less and it prefers more economical utilization of community waste.

CALCULLATION OF COSTS according to Hřebíček (2009).

- Containers: a) their leasing, or b): purchasing and depreciations of the price = 626 Czech Crowns/tonne.

- Transport of waste to the landfill: 246 CZK/tonne, where calculated: 1 km of transport = 35 CZK, average utilization of vehicle = 5,7 tonnes, transport distance = 20 km with load + 20 km without load, together 40 km. Total costs = (35*40) : 5,7 = 246.
- Deposit in the landfill = 1126 CZK/tonne
- Total costs = 626 + 246 + 1162 = 2034 CZK/tonne

INCINERATION OF WASTE
This is a procedure used in households or in special plants.
Solid household waste is burnt into gas and ashes. The original volume of waste decreases to only 10–30% of original volume. Final product of incineration is heat, steam and ashes.

But this is a problematic method because of harmful, hazardous gas emissions. The higher the temperature of burning, the less of these pollutants are emitted into the air. Incineration is used especially for hospital waste.

In the Czech Republic there exist 5 incineration plants. Their construction is very expensive and they can be located only in locations with dense settlement so that transport does not cost so much. Also in Japan, where there is less land, incineration is very often used.

AGAINST INCINERATION
The often used argument against incineration is the pollution of the atmosphere. Incineration truly deteriorates the atmosphere, but with the use of new technologies this pollution could be very small. Similar hazardous emissions also produce family houses (but without elimination of pollutants) when burning solid fuels, and also motor cars in transport.

ENERGETIC UTILIZATION – 2 ways:

1. Direct incineration + using heat to produce energy.
2. Production of gasses, which can have next energetic utilization. As energetic utilization such as incineration is considered, when used material do not need to burn any other supportive fuel (except of short time if igniting) and the produced heat must be used for our or other persons need.

BENEFITS OF ENERGETIC UTILIZATION

- Savings of irreplaceable sources of fuels (crude oil, coal).
- Decreasing the volume of waste deposited in landfills.

Incineration generates fly ashes and cinder. Most of them can be used in the building industry as building materials, the rest ends in landfills, it is about 10 % of the original material volume.

BIOLOGICALLY DEGRADABLE WASTE
Bio-waste – degradable waste through biological processes. More than 40% of municipal waste is created by bio-waste. Into this category fall bits of plants, paper, grass from gardens, etc. Finished organic material can be used as mulch or organic manure (compost).

Bio-waste can be processed also by the technology of anaerobic digestion, when besides organic manure also bio-gas is generated, that can be used to heat or for electric power production.

Bio-degradable waste should be collected separately for next processing as mentioned and so reduce its deposit in landfills, where it generates greenhouse gas – methane.

But there is another problem of composting: who will buy compost and pay for it? This question must be solved firstly. The next problem is that into organic materials for composting, not only typically compost materials are collected, but often also materials containing an excessive volume of heavy metals which then, when compost was used, comes into top soil. These heavy metals then travel into food products and into the human organism. For this reason, attention must be given as to what material is used for composting.

10.5 Some industrial waste groups (not municipal waste)

10.5.1 Building and demolitions waste

This waste takes origin during the preparation of building structures, their maintenance or removing. They create about ¼ production of all industrial waste sorts.

This waste represents a significant source of secondary raw-materials. In the Czech Republic there is a plan to utilize 75% of it, starting in 2012.

This material group involves not only material from buildings, but also from road constructions; that is earth, stones, sand, concrete, ceramics, woods, metals, asphalt, tiles, mortar, cables, panels, glass, textile, plastic.

10.5.2 Sediments from sewage waste water treatment plants

These sediments are inevitable part of water purification. The aim is to prevent unfavourable impacts on the environment and human health, so permanently increasing the percentage of used water that must be treated in these plants.

It is not possible to prevent the production of these sediments but better technology can decrease their quantity. In our republic it is prohibited to deposit these sediments in landfills.

10.5.3 Old ecology loads

In the past, hazardous waste (pesticides, some materials from crude oil processing etc.) from specific enterprises were deposited in not-convenient places, where water could penetrate into the subsoil and damage water resources. These deposits are located mostly in former military areas, areas of agriculture enterprises or near mines.

After 1990, some firms also imported waste from foreign countries to the Czech Republic (for this activity they received much money), they deposited this material in deserted locations and later proclaimed bankruptcy. Now the state authorities must take care of it, which requires much money, because the soil must be removed and sterilized.

10.5.4 Cosmic waste – a new waste category

Cosmic waste took its origin in the mid of the 20th century when people started to launch satellites around the Earth.

Packages, coverings and other helping materials, preventing expensive apparatus against high temperatures during the throughput of the atmosphere stayed in orbit (at about 400 km distance from the Earth's surface), than due to resistance of the air they decrease lower and burn in atmosphere.

It is estimated that presently around the Earth circle at this high about 20 000 pieces with dimensions bigger than 5 cm, which all must be monitored and which represent a big threat for newly launched satellites, especially those with a human crew.

They move at the speed of 8 km/sec and in cases of mutual encounter they shatter into a big quantity of smaller fragments (a Chinese experiment with shooting down their own satellite has been from this point of view very dangerous.

NEWS FROM THE PRESS
A serious problem which makes waste in extreme conditions, often visited by the tourists (Mt. Everest). When they are descending, many mountain climbers do not have enough energy and they throw away all that they do not need any more. For this reason the government of Nepal supports local Sherpas (mountain climber leaders) that collect this waste and it pays them for this activity.

10.6 Liquidation of specific products

According to our law, producers have a duty to withdraw (take back) specific products after their life-time cycle from customers. Because there are many producers and it would be difficult to fulfil this duty for each producer, they founded the so called "collective systems".

Each such collective system can be practised only on the basis of authorisation by the Ministry of Environment. Founders and partners of collective systems are only producers of relevant special products. Collective systems operate on the basis of non-profit organizations.

Producers fulfil the duty of reverse take-off of their own products. Of course, some producers can accept their products through reverse logistics without a collective system. Collective systems are designated for reverse take-off of cars, lamps, freezers etc.

10.6.1 Recycling of old cars

A car weights on average 1 tonne. Received material can be utilized in two ways:

1. Dismantling some parts and their reuse.
2. Scrapping the rest of the parts.

Steps for dismantling:

- Operating liquids (fuels, engine and hydraulic oil, brake liquids, liquids as protection against frost).
- Batteries and containers with liquid gas.
- Airbags.
- Components containing mercury.
- Dismantled are also components which can serve as spare parts (engine, lights) or to next recycling (glasses, big parts of plastics).

- The rest of the undercarriage and the body is scrapped in a big scrapper. Material is scrapped until the parts can fall through a sieve with required openings (orifices). Then, by means of magnets, metal and non-metal parts are separated. Through next special processing also Mg, Zn, glass, plastics, rubber, textile can be separated.

It is a paradox that if car assembly is on such high level in automated assembly halls, but that dismantling must be carried out usually by hand and with a great share of waste time.

In Germany some people speculated about a central enterprise for dismantling cars, but with regard to great transport costs, it is at present time used only a "small island system". An automatic system of dismantling is possible only with the same type of cars and from the same producer.

But when a small island system is used, it is more flexible, because individual workplaces are not joined, they work independently. Disadvantage is that at each workplace the necessary tools and equipment for dismantling must be available.

10.6.2 Recycling of old tires

In the past there were in our country many illegal waste dumps with old tires. Today tires are liquidated first of all by heat processing. The basic components of tires are: caoutchouc, soot, steel, textile + different supplementary materials.

Table 10.2

Caoutchouc	48 %
Soot	23 %
Steel	18 %
Supplementary materials	8 %
Textile	3 %

One tire of a car weights 8 kg, of a lorry 55 kg. In industrial countries, it can be possible to consider on average with one eliminated tire per inhabitant/year. Non damaged tires can be retreated, remoulded.

In other cases tires can be used in cement plants as propellant or for the production of granulates that can be used as components for next products. Old tires can also be used as covering material on silage pits or bumpers in ports for ships.

HEAT UTILIZATION OF TIRES – they provide 20–30 thousands of kJ/kg, that responds to the energetic value of hard coal. For this reason they are used in cement plants. Granules and powder are used, for example, for materials which cover sport fields with an artificial surface. Relatively many tires are exported to less developed countries.

10.6.3 Recycling of electric and electronic apparatuses

Collective systems for these products are: ASEKOL, ECOLAMP, ELECTROWIN, OFO RECYCLING, REMA SYSTEM, RETELA et others. Processing and recycling of electro-waste can be divided into three steps:

- Collecting, purchase, transport and storing,
- Preliminary sorting and dismantling,
- Processing.

Scrap of these apparatuses contains on average: 61% metals, 21% plastics, 5% glass, the share of electronic parts is only 3%. The rest is wood, paper and others, together 10%.

By means of manual dismantling, there can be obtained really “pure” substances. Usually suitable steps are used, which makes it possible to receive:

- (Remove) hazardous parts,
- Iron metals,
- Non-iron metals,
- Plastics,
- Wood,
- Rubber,
- Monitors,
- Cables,
- Batteries,
- Metal parts joined fixed with plastics,
- Platinum.

10.6.4 Recycling of refrigerators

In processing refrigerators, special care must be taken to reverse recycling of cooling substances which usually contain compounds of chlorine, fluorine (freons).

These compounds harm the ozone layer in the atmosphere. On the Earth's surface they are stable but in the atmosphere they are decomposed because of energeti-

cally rich radiation from sunshine. Free chlorine then reacts with ozone and continually damages it. Nowadays there is a prohibition to use such substances in cooling equipment, except for medical equipment. In spite of this, some old refrigerators can appear in recycling, which contain this gas.

10.6.5 Are people also products of recycled materials?

It is true from the astronomic and cosmic view.

People usually consider recycled materials as materials with lower quality and use them until there are not others available. But we must become conscious that all people on our Earth took their origin from recycled materials – and that is a scientific reality.

After the origin of the Universe (after Big-Bang, 13.8 billion years ago), very soon in the cosmic scale, the first stars arose. They were much larger than our Sun (100–1000x), but they existed a relatively short time, some million years only. They consisted exclusively of Helium He, 28%) and Hydrogen (70%). Other elements did not yet exist. In the centre of such stars there were high temperatures and pressure and so there soon started thermonuclear reaction.

This reaction produced not only heavier elements such as sulphur, calcium and others, but also energy in the form of radiation. Radiation pushed all material out from the centre of the stars but another force, gravitation, pulled it in the reverse direction – to the centre. Until new elements originated, these forces were equally balanced and the star was stable, until in the star prevailed as a new element iron. Iron could not create new elements and energy and so in the star prevailed gravitation.

In a very short time of some minutes the whole mass of the star collapsed and fell into the centre, then exploded and their mass dispersed into the surrounding space. Now we say that a supernova exploded. In the former centre of the star there remained only a very small but heavy new star or only a so called “black hole”.

Dispersed gas which now contained all known elements concentrated later into stars of the second generation, as for example our Sun and around it planets including our Earth, where later appeared life and also people.

What was for the star of first generation only waste, was thrown away and this material has been later recycled into new and better forms. We can say that also from these recycled materials originated something of higher quality, as for example, people and human civilization. Or not?

Questions

1. What is the definition of waste?
2. How much of municipal waste falls on one person/year in the Czech Republic? How much in the most developed countries of EU?
3. Explain the waste hierarchy. Which activities do we prefer and which should be restricted?
4. Explain the use of different colours on containers for waste.
5. Explain the problems with the recycling of old cars.

11 Outsourcing, partnership

Chapter objectives

- It had already been proved during the last centuries that labour division helps to improve organization and increases productivity.
- Labour division followed by specialization was used first in individual enterprises.
- Now, in the era of globalization, we can see that it crosses over the borders of the firm in the form of outsourcing, when firms pass over some operations to a specialized subject, which can do them more effectively.
- Managing the Supply chain also needs more cooperation between existing links to gain better competitiveness.
- Between some links in the Supply chain there arise partnership relations, which need mutual trust, but can significantly influence management in the Supply chain.

11.1 Outsourcing

The term Outsourcing is an abbreviation of “outside” and “resourcing”. It means to transfer some production functions or services, which don’t belong among the key competencies of the firm to an external service provider. From logistic activities, usually transport or warehousing, picking, packaging or expediting are outsourced.

More organizations have experience that they can benefit from concentrating on their own operations and outsource peripheral activities to specialists. These peripheral activities might be anything from cleaning and catering through to accounting, legal services and information processing. It is particularly common for organisations to outsource some of their logistics activities to specialists, service providers – perhaps starting with transport, extending to warehousing, and on other tasks in logistics. This use of Third Party Logistics (3PL) can give the benefits of lower fixed costs, expert services, combined work to give economies of sca-

le, flexible capacity, lower exposure to risk, increased geographical coverage and guaranteed service levels. (WATERS 2009).

INSOURCING
It means intrinsic, domestic utilization of resources. The firm itself ensures all activities necessary to fulfil customer's demand.

OFFSHORING
This is represented by transforming the business products from one country to other. This may concern both manufacturing and services. For example, many businesses from Europeans firms have been transferred to China.

REASONS FOR APPLYING OUTSOURCING

- Flexible reaction on customer's wishes.
- Effort to reach in short time world's level or to maintain this level without big effort.
- Activities performed by a specialized, external provider for a bigger number of partners are usually cheaper due to better use of fixed costs.
- Employees are specialized only on a narrower part of activities.
- The production firm can concentrate effort only on its main purpose, production activity, and not to be engaged in many subsidiary, secondary activities and issues.
- For many firms it is not possible to master all global activities only by themselves, they need a partner for outsourcing.

PREREQUISITIES FOR OUTSOURCING INTRODUCTION
The firm must firstly have an evident, transparent strategy. It must define its own key and subsidiary activities. Then it is possible to decide on which activity can be forced out for outsourcing.

OUTSOURCING IN UNUSUAL SITUATIONS

- USA: Protection of representative offices abroad (embassies etc.) secure private local agencies.
- USA: Space program, for example new space shuttle, for transport of cosmonauts to International space station develop private organizations.

HOW TO CHOOSE THE BEST PROVIDER?

- What, from whom and to whom must be material or goods delivered.

- Make an arrangement of material flows: where will the interface be, from which the provider takes over the responsibility for goods or materials.
- Prompt reaction.
- Price of outsourcing.
- Division of responsibility between partners.
- Ways of measuring and monitoring outsourced activities.

Table 11.1 Advantages – disadvantages of Out- and Insourcing

	Outsourcing	Insourcing
Advantages	• Access to world's market • Utilization of new technologies without high investments • Decreasing investments	• High operational ability
Disadvantages	• Low operational ability • Irreversibility of decisions • Management of relations instead of management of operations • Uncontrolled flow of discrete information out of the firm • Difficult defined benefits	• Difficult to keep world's level • Necessity of investments • Risk of stagnation

PRODUCTION OFFSHORING

- Physical transfer of production to countries with lower costs (no longer today's China).
- Research and development of products is usually not transferred, mother countries have more qualified labour forces.
- Firstly, patent the products and technologies in the new country – secure know-how, if possible.
- Some decades ago, US firms offshored to China and Mexico, where there were low rights of workers, low prices of land, low control of environmental damage and where there was big demand in the cities.

SERVICE OFFSHORING

This is connected with the expansion of communication infrastructure and digitalization. Specialists from China, India, gradually replace specialists from the Western countries.

There is an advantage especially for Indian people, who know the English language perfectly. For example, the producer of computers DELL moved necessary technical support for US clients to India. When the client in the USA dials a certain number for technical support, he is connected with technicians in India, who will give him advice. But he thinks he's speaking with somebody in the USA.

CONSEQUENCES
Receiving country:

- Higher level of employment.
- Higher GDP (Gross Domestic Product).

Original country:

- Higher profit – lower costs.
- Less possibilities for workers (vacancies), workers must be retrained.
- China and India become competitors, gradually takes over design and development of new products.

EXAMPLE
When a firm in the USA does not have the possibility to develop a new product, it orders it from an outsourced firm specialized on "new product development". This firm does the complete proposal and sells it to the client, which only adds a label with his own name on it. In the US, about 30% of digital cameras or 65% of MRP players are produced in this way.

Results of own investigation

Table 11.2 Outsourcing (%) – own research in SME
(Small and medium sized enterprises)

Number of employees	Number of firms	Outsourcing used
1–9	20	40.0
10–24	61	42.6
25–49	35	45.7
10–49	96	43.8
50–249	61	77.0
1–249	177	54.8

Own source

Table 11.3 Outsourcing according to the size of enterprises in %
(number of enterprises 185)

Activity	Number of employees in the firm						
	1–9	10–24	25–49	Σ10–49	50–249	Total	%
Number of firms	20	69	35	104	61	185	100,0
Accountancy	7	19	7	26	13	46	24.9
Maintenance	1	10	10	20	22	43	23.2
Transport	2	12	5	17	30	49	26.5
Marketing	1	5	3	8	14	23	12.4
Taxes	1	1	1	2	3	6	3.2
Work security	0	0	0	0	3	3	1.6
Legal services	0	0	0	0	6	6	3.2
Security	0	0	0	0	3	3	1.6
Research	0	1	0	1	5	6	3.2
Craft	0	3	2	5	1	6	3.2
Cleaning	0	3	0	3	5	8	4.4
Installation	0	1	0	1	2	3	1.6
Total	13	56	29	85	115	213	––
Activities/firm	0.65	0.81	0.83	0.82	1.88	1.17	––

Own source

11.2 Integration and partnership

Logistics in an enterprise has traditionally been perceived as a sequence of successive operations which add value to the final product. These operations were managed as detached, differently, so that the enterprise could have independent departments for purchasing, transport, warehousing, inventory management, distribution, etc. But in such organization originated many problems.

Purchasing may look for the most reliable suppliers, Inventory management for low unit costs, warehousing for fast stock turnover, materials management for easy handling, transport for full vehicle loads, and so on.

These aims are all worthy, but problems appear when these separate aims come into conflict. For example, purchasing can reduce its administrative costs by sending fewer, larger orders to suppliers – but this increases stock levels and raises the amount of money tied up in the warehouse, etc. In reality, the activities of logistics are very closely related and actions in one inevitably affect the others.

To avoid problems with a fragmented Supply Chains, is necessary to bring the activities together and consider logistics not as a series of distinct tasks, but as a single integrated function. Then, all the parts work together to get the best overall result for the organisation – and for the customers. Integrated logistics within an organisation has all the related activities working together as a single function.

We have described the benefits of integrated logistics within an organization, but we can extend these arguments to suggest the same benefits for integrated logistics along the whole supply chain.

If organizations within a supply chain only look at their own operations, there are unnecessary boundaries between them that disrupt the flow of materials and increase costs. Similarly, as internal integration removes the boundaries within an organization, external integration removes them in the longer chain and external firms cooperate to improve performance in the whole chain.

Conclusion – 3 steps of integration:

1. Logistics as a separate activity within an organization
2. Internal integration to bring these separate operations together into a single function
3. External integration where organizations look beyond their own operations and integrate more of the supply chain.

External integration is difficult and develops over time. For example, two companies start with reducing transport costs by coordinating their flows of material. Over time, the integration may progress from the coordination of physical movements to information flows, control over material movements, and then to the design and working of the infrastructure.

The initial step to integration is that all organizations recognize that they share the same overriding aim of satisfying customers. This may seem obvious but trading partners must overcome the traditional adversarial view.

When an organisation pays money to its suppliers, people assume that one can only benefit at the expense of the other. If the organization gets a good deal, it automatically means that the supplier is losing out. If the supplier makes a good profit, it means that the organization pays too much. The result is uncertainty about the number and size of orders, constantly changing suppliers and customers etc.

Organizations have to recognize that it is in their own long-term interest to replace conflicts by agreements. This may need a major change of culture.

Table 11.4 Different views with conflict and cooperation

Factor	Conflict	Cooperation
Profit	One organization profits at the expense of the other	Both share rewards
Price	As high/low as possible	Agreed at reasonable level
Relationship	One is dominant	Equal partners
Trust	Little	Considerable
Time-frame	Single order	Long term
Communication	Limited and formal	Widespread and open with shared systems
Information	Secretive	Open and shared
Contract	Rigid	Flexible
Focus on	Own operations	Customers

Source: Waters

To improve the partnership, it can also help the application of e-procurement and CRM – Customer relations management. In both cases the problem is in sharing information.

Non formal cooperation
When a firm has had a good experience with some supplier, it purchases repeatedly from him and so a good relation is formed. But there is no commitment and the firm can change the supplier immediately. Such an arrangement is flexible but without obligations.

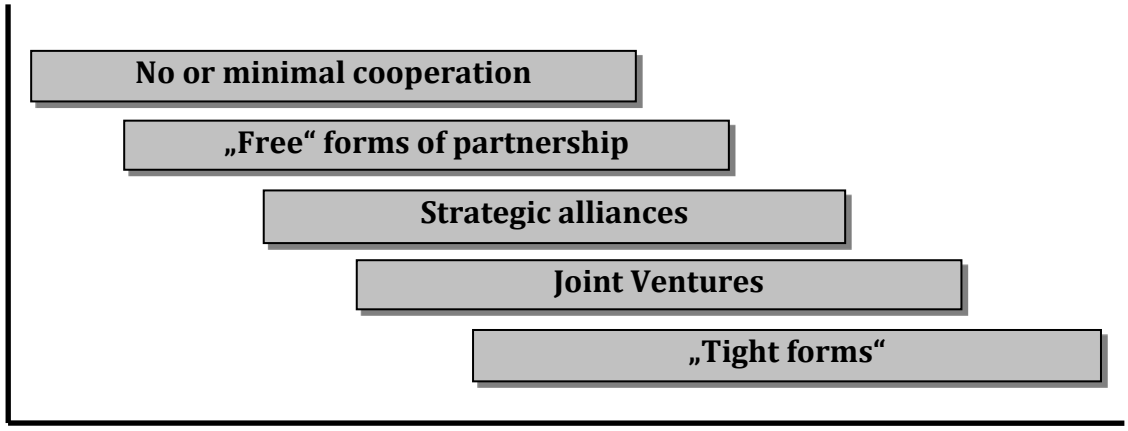
Disadvantage: any firm can finish with their cooperation and so cause others big problems. For this reason, the majority of firms prefer a written agreement with tasks for all involved subjects. Of course, no contract can guarantee that the contract will not be broken by some subject.

11.3 Strategic alliances

A strategic alliance is a formal, long-term relationship between two or more organisations to pursue a set of agreed goals or achieve a specialized business need. The organizations remain independent but work closely together to achieve their mutual aims.

Strategic alliance
It is a higher form of cooperation between two or more firms (partners) than a simple cooperation by means of outsourcing. A strategic alliance is formed by two or more independent organizational units (strategic partners). On the basis of mutually formulated strategic goals and successive tactical and operational goals, a strategic alliance acts as a relatively autonomous enterprise unit.

Figure 11.1 Evolution of cooperation between enterprises



Source: Vodáček, Vodáčková, 2002

Organizations stay independent. Main features of formal alliances are:

- Organizations work closely together on all levels.
- They share common entrepreneurial culture and goals.
- Long-term cooperation.
- Sharing information, experience, planning.
- Flexibility and willingness to solve shared problems.
- Continuous improvement of all activities.
- Agreement on the level of costs, profit, so that the resulting price will be competitive.

Forming an alliance is only the first step and it is still necessary for much effort so that organisation works successfully. The result can then be seen at the level of provided services, volume of business, increase of profit, shared projects, merging (mixing) firm culture etc.

Vertical integration

If the organisation needs to continue behind the partnership, it must possess, at least partially (or fully) some links of the Supply chain. For example, to have at least a minimal ownership of the other link. Then it has the possibility to express, widen into its activity, but cannot immediately control it.

The producer can have, for example, a certain share in the link “warehousing” to influence the way of product distribution. Or the retailer can have a share in a transport company to influence its transport policy.

Joint venture
This is another way of cooperation. Two organisations put their sources together and found a third company with shared ownership. For example, the producer and distributor can found a transport company which will transport materials between them. So the possibility of 3PL control will be extended but both original organisations will share the risk and profit.

The most frequent way of arrangement is when one organisation can buy the second in the Supply chain. This increases the level of vertical integration (Vertical integration is a part of SC, owned by one organisation, proprietor).

If the organisation owes mainly links (tiers) backward the flow – (up the stream - raw materials suppliers, warehouses, transport..), it is backward integration. If the organisation owes mainly links (tiers) down the stream, it is forward integration.

It has already been mentioned that such backward integration was established by H. Ford many years ago, but such gigantic integration could not be centrally managed in changing conditions. It has been too expensive, bureaucratic and little flexible.

The majority of organisations focus only on some ownership of links in the Supply chain. Integration becomes possible till the time when new technologies of sharing information were available.

Choice of partners
Strategic alliances also have a negative aspect – careful choice of partners. Only some organisations can succeed.
The result: both the number of suppliers and logistic providers is radically reduced.

For example, Rank Xerox Manufacturing in Holland reduced the number of suppliers from 3000 to only 300.

Similar solutions can be found in other world's organisations, some of them solved to have only one supplier. That seems to be good for partnership or control, but there is a risk, if he fails, the consequences can destroy the key partner.

For example-when there was a tsunami in East Asia and suppliers cannot deliver parts for assembling computers in Europe. So it is always good to have more than one partner for the basic supply.

Questions

1. Explain the difference between outsourcing and offshoring
2. Which operations are outsourced mostly?
3. Which information must the firm receive and evaluate before concluding a form of partnership?
4. Enumerate some different forms of cooperation between enterprises.
5. What is the difference between horizontal and vertical integration?

12 Management of the supply chain

Chapter objectives

- Formerly nobody took care of managing the Supply chain, this term had not been known yet. In spite of this, businesses existed and flourished.
- Later, mainly in the time of globalization, firms saw, how big a potential there existed in the Supply chain and how it could be effectively used in competition.
- Management of the SC means to eliminate from it all unnecessary links, unnecessary activities and construct it so, that it would be more attractive for consumers.
- It must deliver goods according to consumers' demands, with high value added for customers, very quickly, at acceptable price and with high flexibility.
- All these demands must be successfully managed.

12.1 Competitiveness trend: from the firm to the supply chain

Already some decades ago it was clear that a big potential to increase the value added for the end consumer lies in the sphere of Supply Chain. Some links of the SC follow mainly own narrow objectives and more than consumer satisfaction, they are interested of own, individual benefits.

Other links in the SC perceive the necessity to be oriented towards the end consumer´s satisfaction and try to realize it by means of a higher level of inventories, which can be promptly and flexible delivered – but this way increases the costs and has no perspective.

It is necessary that all links of the SC join their effort and act together to coordinate and reach the synergetic effect. This is higher than a sum of non-coordinated activities of these links.

Key link is such link in the SC which manages other downstream and upstream links. More about this is in chapter 2. Key link in the supply chain is such a link that invested much into technological facilities or into marketing, research, development in the past to build a good name of the firm and operates in big, global area. To gain back these investments, know-how, it has to use maximally available capacity and manage the material flow in the supply chain.

What does it represent for the management of the supply chain?

1. To eliminate all unnecessary links in the chain and so decrease costs of the final product (usually unnecessary transport, storing…).

2. To increase the value added for the customer (better quality, flexibility, faster delivery, tailored products etc.).

As compensation for loss of some independence, the key link offers to other neighbouring links long time contracts, sometimes it also helps with better know-how etc.

How to manage the Supply Chain to fulfil clients' demands?

1. MANAGEMENT BY THE PROPRIETOR

All links, segments of the chain possess only one proprietor and so it can manage all parts of the chain directly. H. Ford sometimes tried to possess such a SC. After the big success of car production on assembly belts, he tried also to possess the firms of his suppliers – steelworks for metal sheet production, glass factories for production of car glasses, caoutchouc plantations in South America to receive raw material for tire production, etc.

But such a giant could not be managed when demand substantially fluctuates and so such effort came in vain. Direct management can exist only as restricted and timely only in some special cases.

2. MANAGEMENT BY THE KEY LINK

The key link in the car industry is the assembly plant because there the products are finalized and their assemblage demands big technology investments, which cannot be idle, if production should be effective. For this reason this key link coordinates deliveries from its suppliers (first-, second-, third tier supplier) and makes partnership agreements for more years of collaboration.

If one link does not wish to lose part of its independence as exchange for the long time advantages of cooperation, it has to be exchanged. This change makes the key link.

12.2 Forms of SC management by means of the key link

12.2.1 Upstream management of the supply chain – to find the best Supplier

e-PROCUREMENT
e-Procurement is a centralized purchase, oriented on automation of purchase processes and electronic communication with suppliers. Costs decrease by means of elimination of paper documents, automated processing of purchase demands, minimization of errors and using EDI – Electronic Data Interchange with suppliers. Users have immediate access to current information concerning their demands, current situation of their budget, current delivery, etc.

All this take place on an electronic marketplace, on which suppliers place their catalogues with offered items of goods and prices and buyers can compare, chose, negotiate and obtain new business partners.

But new partners come into consideration mainly on such businesses, commodities, which on the market often change or which are demanded irregularly. If we have a reliable supplier, there is no sense in changing him, but rather to negotiate better price with him.

Electronic marketplace is similar to such systems broadly used in transportation, where different firms place their demand, what goods and where to transport them, and transport operators can so receive promptly necessary information and make an order. This system includes all European countries.

12.2.2 Downstream the supply chain

CRM – CUSTOMER RELATIONSHIP MANAGEMENT
This is the approach of identification and recruiting new and keeping all existing customers. With this issue also the problem of data security is connected, first of all from the view of legal aspects of different countries, and customers not to provide their data to other persons or companies.

CRM records, stores in a database and then uses this available information in such a way that improves the relationship with customers. It is a strategy oriented on establishing and supporting of a long-time relationship with customers.

THE OBJECTIVE OF CRM

- Maintaining contemporary clients, ability to address new customers.

- Understand the needs of customers.
- Increase satisfaction through improving key activities.

All communication with customers is monitored and stored in the database and when necessary, effectively used. It also makes it possible to communicate with different persons by means of different communications channels and in different time (web, call centres, dealers, vendors..).

Investigations show that companies having satisfied and loyal customers have more repetitive businesses, lower costs for recruiting new customers and a more powerful brand.

ECR – EFFICIENT CONSUMER RESPONSE
This is a logistic PULL system, where instructions for production, transport and replenishing of goods are given depending on the client's demand. All parts of the SC, starting from suppliers, then producers, to retailers cooperate consistently and share all information of demand and goods transportation from the vendors' place (customer) backwards, opposite to the material flow.

ASSERTING ECR
Cuts the time between the ordering of goods and their placement on shelves.
Decreases transportation costs.
Decreases costs concerning storing of redundant inventories, it removes them.

PREREQUISITIES OF ECR APPLICATION:

- EDI;
- Automated identification of goods (bar codes, RFID);
- Electronic transfer of money;
- Cross-docking.

ECR is appropriate for the food processing industry of goods, or for other goods with short term turnover.

In other words: it is an effort to accelerate the movement of goods from the producer to the client and how to make it cheaper. The basis for it is the client's demand and beside this all activities of the links in the SC must be adjusted.

ECR originated in the last decade of the 20th century as a response to the expanding information technologies in the SC. Without ECR, individual links in the SC will assert different strategies. Warehousing prefers purchasing in big quantities to receive savings resulting from economy of scale. But retailers prefer batches in

smaller quantities, in a broad assortment. As a result of these different strategies, inventory in different parts of the SC increases.

12.2.3 Management the SC by means of an external subject-4PL

Some activities of the SC are transferred to external subjects in the form of outsourcing. Such subject then has not only the responsibility to perform them, but also to reach planned parameters. In manufacturing, most often transport and storing operations are outsourced.

Between two subjects (the producer and the customer) a new subject (3PL, 3-Party Logistics) enters, which is specialized in performing these activities. Because this subject practices them for more firms, it has more experience and better utilization of techniques that results in lower costs.

When we speak about 3PL, there can be the question whether 2PL also exists? Yes, but this term is not used. It represents only the relationship between 2 links (tiers) of the SC, without any intermediary.

Figure 12.1 Third Party Logistics (3PL)

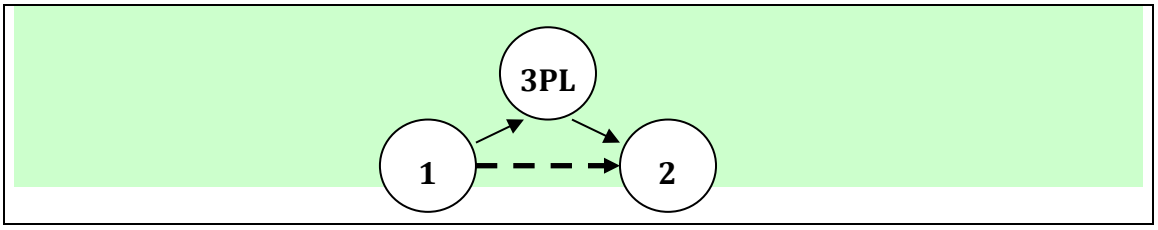
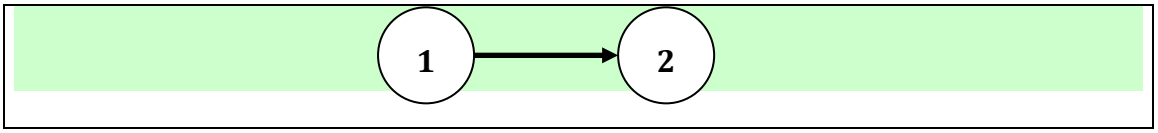


Figure 12.2 Second Party Logistics



3PL Characteristics

- They possess or hire the transport fleet.
- They possess or hire warehouses and operate them.
- They employ many workers.
- They offer a certain degree of value added of services, for example, packaging, labelling consignments, transport.
- They use IT only for partial solutions, such as transport route optimization, planning.

Criterion for 3PL selection

1. The level of offered services
2. Quality of employees
3. Price
4. Experience
5. Size of the 3PL firm.

Reasons for the possible dissatisfaction with 3PL

1. Failure of services
2. Bad quality of 3PL management
3. Insufficient transfer of information
4. Orientation mainly on technique utilization (trailers, warehouses)
5. Incapability to reach demanded flexibility
6. Level of prices
7. Solving only partial issues, not the whole SC
8. Service providers do not have their own research, development, concerning new technologies and project management.

Figure 12.3 Fourth Party Logistics (4PL)

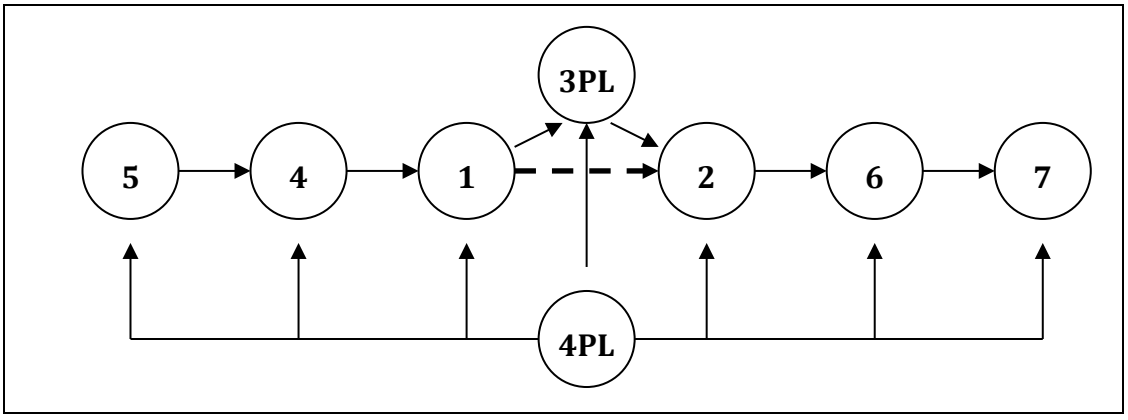
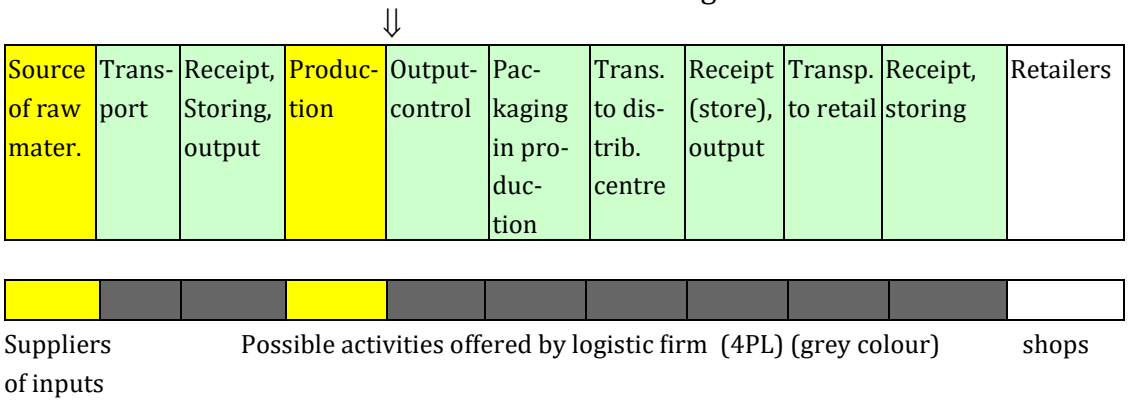


Figure 12.4 Diagram of the SC, managed by a Logistic firm (4PL)



LOGISTIC ENTERPTISE, 4PL

Provider of logistic services, who in contrast with classic providers (transport providers, providers of warehousing, providers of 3PL etc.), offer to their clients as a service, management of the whole Supply chain (coordination, optimization) – today this exists only rarely).

If an external firm takes over management, not only between two links (tiers) but among all links in the SC, it will be addressed (labelled) as 4PL Party Logistics). The original firm only performs basic activities on which it is specialized and material supply or distribution of products operate the 4PL.

A key link can also be represented by a group of 4PL (Party Logistic). As an example from literature often presented is the Spanish firm ZARA. But as a suitable example, also one US distribution chain can be presented. It decided for the next year to deliver to market a big quantity of winter sportswear of standard quality, at relatively low prices and with its own business brand.

It set aside a small specialized marketing department, 4PL. This firstly makes clear exact intentions, what to sell, in which quantity, quality and for which price. Then it offered for every individual item an exact plan concerning the model, size, material, costs, etc. These plans were then offered to different Asian producers. With those who accepted these plans, contracts were concluded, including fixed terms, when and where goods should be delivered and consolidated and loaded on ship. In the USA, this chain can now start an extensive marketing campaign and prepare customers for this offer. All these activities were unique and were not repeated in the following years.

4PL: Possible services on input (example)

- Transport of all necessary materials, work-in-processed materials and parts from suppliers.

- Receipts of deliveries and their storing in storehouses of the manufacturing firm.
- Distribution (output) of these materials for next production.

4PL: Possible services in production and distribution (example)

- Output control;
- Completion and packaging;
- Storing of finished products;
- Expedition of finished products;
- Transport of finished products to clients and their storing.

4PL is a complex service involving analysis, projecting, realization and management of integrated SC by 4PL providers. Provider can in such situations eliminate activities that do not add value and make the chain more competitive.

It is not expected that 4PL will have big material property, but rather suitable software and IT. Also, the number of employees in 4PL should not be high. The aim is to discover in the next value added for clients and be able to realize it with all participating partners.

Demands on 4PL:

- It should have outstanding experience with IT implementation.
- It can manage information flows.
- It is able to implement innovations.
- It can extract, dig out value added for customer from existing SC comparing it with the level of world's best companies.
- It is able to propose a system to divide next profits among all participating subjects.

Questions

1. It is remarkable that a Supply chain with many independent links can exist without any special managerial unit, department. How is it possible?
2. What is the difference between SC management now and one hundred years ago?
3. What are the most important objectives in the SC management and how to achieve them?
4. Explain activities of the CRM (Customer Relations management) and ECR (Efficient Customer Response).
5. What is 3PL? How does it help in managing the SC?
6. What do we expect from 4PL? Does it already exist somewhere?

13 Production and environment

Chapter objectives

- The biggest issue which the world's population has had to solve since the beginning and through the whole 21st century, has been sustainability.
- The climate change through global warming has led to a focus on human and economic activity, which have the potential to influence the long-term sustainability of the planet.
- Manufacturing has a substantial impact on climate change and it is necessary to find solutions to stop this negative impact or at least to slow it down.

13.1 Introduction

The mostly widely used DEFINITION OF SUSTAINABILITY:
Sustainability is about meeting the needs of the present population without compromising the ability of future generations to meet their own needs (Christopher).

THE TRIPLE BOTTOM LINE
The definition of sustainability can be further augmented by adopting the parallel idea of the triple bottom line. This concept emphasizes the importance of examining the impact of business decisions on three key areas:

- Environment (e.g. pollution, climate change, the depletion of scarce resources etc.) – **PLANET;**
- Economy (e.g. effect on people's livelihoods, – sufficiency of food, cheap food, - profitability of business etc.) – **PROFIT;**
- Society (e.g. poverty reduction, improvement of working and living conditions etc.) – **PEOPLE.**

These three elements – 3Ps = PLANET + PROFIT + PEOPLE, are inevitably intertwined.

They remind us that for a business to be truly sustainable, it must pay attention to the wider impact of the activities it undertakes if it seeks to remain viable and profitable.

Example:
Strategies that benefit the wider environment are also likely to involve less cost in the long term as a result of a better use of resources. If a firm utilizes transport capacity more efficiently through better routing and scheduling, then not only are emissions of transport reduced, but also the costs to the company.

13.2 Greenhouse gasses and sustainability

Recent years have seen a considerable growth of awareness of the potential harm to the environment that can be caused by so-called "greenhouse gasses".

These gasses include carbon dioxide, methane, nitrous oxide and various fluorocarbons. These emissions are often referred to as a "Carbon Footprint". CO_2 emissions make up 85% of all these gasses and this is also the reason why controlling it is so important.

Sometimes we can use the equation: 1 t C = 3,67 t CO_2.

Table 13.1 The global warming potential of the six Kyoto greenhouse gasses

Greenhouse gas	Global Warming Potential (DWP) – DEFRA	Global Warming Potential (GWP) IPCC
Carbon dioxide (CO_2)	1	1
Methane (CH_4)	21	25
Nitrous oxide (N_2O)	310	298
Hydrofluorocarbons (HFC)	140–11 700	124–14 800
Perfluorocarbons (PFC)	6 500–9 200	7 390–12 200
Sulphur hexafluoride (SF_6)	23 900	22 800

As a result of increased human activity around the world, the level of these greenhouse gasses has risen significantly over the years. It is estimated that current levels are around 430 ppm (parts per million) compared to 280 ppm before the Industrial Revolution. The increase in greenhouse gas levels is a major cause of climate change.

Even though it has proved difficult to get universal agreement on the best means for reducing greenhouse gasses, there is a widespread acknowledgement that action is required.

Major causes of greenhouse gasses arise from these five activities:

1. Manufacturing
2. Energy production
3. Transportation.

These can be complemented by:

4. Supply Chain activities
5. Private activities of people.

Of course, there are still other non-industrial activities with their share of the carbon footprint, such as heating homes, using private cars, etc. In recent years there has also been a discussion concerning livestock production and life-cycle analysis. Farm animals account for between 20% – 30% of global greenhouse emissions including from the clearing land of trees to cultivation to feed and graze the animals.

However, more important seems to be the so called "Life cycle analysis", which assesses the real environmental impact of the food we eat (energy input and output involved in the production, processing, packaging and transport of food, air pollution, water pollution and waste generation – municipal solid waste).

Manufacturing is very strongly entwined and joined with the environment and can negatively influence its components; atmosphere, water, soil, ecosystems.

Table 13.2 Selected countries according to the production of CO_2 emissions in tonnes in 2010

Country	CO_2 t	Area (km^2)	Population	Emission/person (t)
World	33 508 901	148 940 000	6 852 472 823	4.9
China	8 240 958	9 640 821	1 339 724 852	6.2
USA	5 492 170	9 826 675	312 793 000	17.6
India	2 069 738	3 287 263	1 210 193 422	1.7
Russia	1 688 688	17 075 400	142 946 800	11.8
Japan	1 138 432	377 944	126 056 026	8.9
Germany	762 543	357 021	81 799 600	9.3
Iran	574 667	1 648 195	75 330 000	7.6

Czech Republic, 2008:
Annual CO_2 emissions (thousands tonnes) 116 996.
% of worlds emissions: 0.39

In recent years there has been a growing awareness among consumers of the issue of "Food miles" – in other words – how far food travels from its origin to the

point of final consumption – and what the impact of this might be on carbon emissions.
The **Carbon footprint** could be viewed as a footprint concerning:

- A particular product (service)
- An enterprise (organization)
- The whole Supply Chain.

  Simpler is to find out the carbon footprint of a particular product or an enterprise. The last possibility demand cooperation with downstream and upstream links of the chain to receive necessary data.

SUPPLY CHAIN DECISIONS THAT IMPACT THE RESOURCE FOOTPRINT

1. Design of the product
   * The choice of materials for both the product and the packaging.
   * Focus on opportunities for reuse and recycling.
2. Source
   * Location of suppliers can impact differentially on the resource footprint.
   * Environmental implications of supply source (food miles).
   * Society and ethical issues.
3. Manufacturing
   * Improve energy efficiency.
   * Reducing waste, rework, and scrap.
   * Reduce/eliminate pollution and emissions.
4. Delivery
   * Optimize network configuration.
   * Minimize transport intensity.
   * Reconsider transport modes.
5. Return
   * Develop “reverse logistics” capacities.
   * Manage product end of-life.
   * Create “closed loop” supply chains.

Groups of emissions
Three groups of emissions can be distinguished:

1. First group of emissions: Emissions connected with the production of electricity which is supplied from external suppliers.

2. Second group of emissions: direct emissions from own sources or sources which can be controlled by the audited firm (i.e. emissions from own transport fleet or from chemical reactions in manufacturing processes).

3. Third group of emissions: other non-direct emissions – from outsourced activities or from deposits of stored waste, or produced by service cars (for management etc.).

13.3 First group emissions – production of electricity

Some people think that electricity is a "pure source", with no emissions. However, electricity is only as pure as its production. It can be produced from black or brown coal, by means of water, sunshine, wind, nuclear power, etc.

In the Czech Republic the production of electricity is based on coal sources (54% in 2010), nuclear power (32.7%), while photovoltaic electric power had increased in recent years substantially.

Most harm to the environment, from the view of the carbon footprint, is caused by coal power stations because very bad brown coal is burned, with many admixtures (ingredients).

13.4 Second group emissions

Besides electricity as a source of power for machines and other equipment, the big CO_2 emitter is transport in all its modes:

- Road transport
- Air transport
- Water transport.

13.5 Road transport

Table 13.3 The quantity of pollutants emitted by transport

Fuel type	Unit	Kg CO_2 per unit
Petrol	Litre	2.3154
Diesel	Litre	2.6304
CNG	Kg	2.7278
LPG	Litre	1.4975

CNG = Compressed Natural Gas
LPG = Liquid Petroleum Gas

Source: McKinnon

ENVIRONMENTAL MANAGEMENT STANDARDS (EMS)
EMS is a structured framework for managing an organization's significant impact on the environment. These impacts can include business waste, emissions, energy use, transport and consumption of materials and increasingly, climate change factors.

Table 13.4 Emission standards for heavy-duty diesel engines (g/kWh)

Tier	Date of imple-mentation	CO	HC	NOx	PM
Euro I	1992	4.5	1.1	8.0	0.36
Euro II	1998	4.0	1.1	7.0	0.15
Euro III	2000	2.1	0.66	5.0	0.10
Euro IV	2005	1.5	0.46	3.5	0.02
Euro V	2008	1.5	0.46	2.0	0.02
Euro VI	2013	1.5	0,13	0.4	0.01

Source: www. Nao.org.uk (McKinnon)

DEVELOPMENT OF GREENER VEHICLES (AIRCRAFT AND SHIPS)
Advances in vehicle technology can reduce the environmental impact of freight transport in three ways.

1. Increasing vehicle carrying capacity.
2. Improving energy efficiency.
3. Reducing externalities.

ROAD FREIGHT – TRUCKS
In the EU there exist limits on the maximum gross weight and dimensions of vehicles. The areas for improvement are only possible within these limits.

The weight-carrying capacity of a truck can be increased by reducing its tare (or empty) weight. The use of less dense materials (aluminium) in truck chassis can significantly cut the tare weight.

The application of hybrid technology to rigid lorries engaged in local delivery operations. Research by Volvo suggests that combining diesel and battery power could ultimately improve fuel economy by 50%. Anti-idling devices that automatically switch off the engine when the vehicle is not moving.

Aerodynamic profiling. Integration of the tractor and trailer to permit optimal profiling of the complete vehicle and so eliminate turbulence in the gap behind the tractor unit.

Altering the nature of the fuel energy source: switch from conventional diesel to alternative fuels (compressed natural gas – CNG or biodiesel mixes – significant emissions reduction).

The "electrification" of trucks through the use of batteries, as a sole or a supplementary power source, cuts diesel fuel consumption.

Engine redesign. Tightening emission standards have forced vehicle manufacturers to radically redesign truck engines over the past 20 years.

13.6 Rail freight operations

Recommendations:

- Maximizing the use of electric traction. This makes zero emissions, if elektricity is not from coal power stations.
- Continue to invest in low emissions diesel locomotives in such situations, where electric traction is not viable.
- Use low-sulphur fuel.

13.7 Air freight

The movement of freight by air is more damaging to the environment, on a tonne-km basis, than by any of the surface freight modes. But it is awaiting the growth of air cargo tonne-kms in the next years.

Some grounds for optimism:
Over the past 40 years the average fuel efficiency of commercial aircraft has risen by 70%, while aircraft coming into service today are around 75% quieter than their predecessors of 20 years ago (ICAO, 2007).

The development, implementation and diffusion of new technologies is to be relatively slow as aviation is essentially "a long life cycle industry". It can take 10 years to design a new aircraft, which will then be manufactured for around 20-30 years. The investment cycle can be as long as 55 years.

Routing through congested European airspace: in 2007 such congestion added on average approximately 50 km to the length of each flight. 5–10% fuel savings can be achieved by using a better management system.

13.8 Water transport

Shipping has traditionally been regarded as the most environmentally sound mode of transport. There are low energy emissions per unit of freight movement.

Example:
A 3700 container ship uses only 0.026 kilowatts to move 1 tonne for 1 km as opposed to 0.067 kWs for diesel powered rail freight, 0.18 kw for a heavy truck and 2 kWs for air freight moved in a Boeing 747.

SULPHUR is a basic problem of the shipping industry.
Ships burn extremely dirty "bunker fuel", rich in sulphur, which is left as a residual fraction in the refining process when clean "distillate" fuels, mainly petrol and diesel used in surface transport, have been extracted. On average, this bunker fuel contains around 27 000 ppm of sulphur, in comparison with 10–15 ppm in the fuels consumed by road vehicles.

The IMO (International Maritime Organization) now limits the sulphur content in bunker fuel to 45% and this maximum should drop to 1.5% by 2020.

13.9 Supply chain emissions and improvements

SUPPLY CHAIN
Historically, a supply chain has been defined as a system whose constituent parts include material suppliers, production facilities, distribution services and customers linked together by the feed-forward flow of materials and the feedback flow of information (McKinnon).

Firms should expect to be charged for their CO_2 emissions and this charge will force changes to the way companies run their supply chains.

Common practices of the last century – long distance airfreight, small batch size, Just-in-time concepts and energy intensive production in countries with low environmental standards-will surely need to change. Reducing the supply chain carbon footprint will become an inescapable obligation.

TRANSPORT INTENSITY
The transport intensity of the supply chain can be measured in a number of ways, but at its simplest it is a reflection of the miles/kilometres travelled per unit of product shipped/per given time period.

What practical steps can an organization take to improve the transport intensity of their supply chains?

- Review product design_and bill of materials (choice of materials, including packaging materials, easy recycling, reuse, and end-of-life disposal).

Example:
Tesco recognized that glass bottles, because of their weight, add significantly to transport intensity and so to the carbon footprint. With producers they created lighter weight wine bottles-a 15% saving. This is significant because wine is delivered from Australia to Europe.

- Review transport options

Different transport modes have different impact on the carbon footprint.

- Improve transport utilization

Vehicle capacity is often poorly utilized (running empty because of the lack of return loads. A third of the trucks on the roads of Europe are running empty).

- Reduce the number of deliveries

During the last 50 years the philosophy of Just-in-time has prevailed. This has led to smaller but more frequent movements of products and materials. The challenge for supply chain managers is to find a solution that enables the benefits of JIT to be gained without incurring the potential environmental disadvantages.

- Review sourcing strategy

Many strategies formerly led to low-cost country locations and products moving great distances.

Example:
SAB Miller (beer producer) compared its water footprint for barley production in two countries: South Africa and the Czech Republic.
In South Africa: 155 litres of water are needed to produce 1 litre of beer (irrigation, evaporation), in the Czech Republic only 45 litres.

As example, the Czech Republic is supplied with many fruits and vegetables from distant countries where they can be produced at lower cost.
However, cost is not the only factor of importance for the consumer. There is also quality and that means that vegetables must be fresh and fruits – such as apples – should have good taste. Such products could be produced in our country too and so decrease the carbon footprint.

WATER: THE NEXT OIL
As the world's population continues to increase and as climate change impacts on rainfall, there is an increasing miss-match between supply of and demand for water.

Table 13.5 Some examples of the water footprint

How much water it takes to make:

A cup of coffee	140 litres
A litre of milk	1000 "
A hamburger	2400 "
A T- shirt	2500 "
Pair of jeans	10 850 "
A kilogram of beef	16 000 "

13.10 The supply chain of the future

The world's population will increase from today's 7 billion to over 9 billion by 2050, but some countries' populations will grow whilst other will shrink.

In 2050, 70 % of the population will live in urban areas. There will be many mega-cities with more than 10 million people. They must be served – a challenge for logistics.

Redistribution of wealth: from the western world to the newly emerging economies. Asia's share of the global market will almost double. The middle classes in the emerging economies are likely to increase from 400 million in 2010 to over 1 billion by 2030. The centres of gravity in many markets will shift – causing a rethink of existing supply chain structures.

The shifting centres of gravity and the growing urbanization of society are trends that are already evident and forward-thinking supply chain planners will already be reworking them into new strategies.

13.11 System of environmental management

ENVIRONMENTAL STANDARDS
The behaviour of an organization towards the environment is recommended by the International Standard Organization (ISO) in regulation ISO14 000 of Environmental Management. It is a voluntary standard but all important enterprises accept it because it is also a significant competitive factor.

This standard only creates a framework without any numerical values concerning for example, emissions-, because organizations differ in technologies or energy

used and it is impossible to formulate international standards with exact values of emissions which every organization will comply with.

ISO 14 000 standards contain only the main principles acceptable for every organization and each enterprise inserts its own standard values with respect to national legislation.

Do we insert strict or vague values? The public will follow and evaluate it, objectives must be acceptable for nearby communities.

Environmental standards concern such aspects of the environment which the enterprise can influence. For example, water, soil, air pollution, natural resources, plants, animals, people.

Management should continually improve its activity and prevent pollution, fulfil current regulations and carry necessary documentation to prove to others that accepted standards are fulfilled.

The international Standard is applicable to any organization that wishes to:

- Implement, maintain and improve an environmental management system.
- Assure itself of its conformance with existing environmental policy.
- Demonstrate such conformance to others.
- Seek certification registration of its environmental management system by an external organization.
- Make a self – declaration of conformance with these international standards.

An organization has to create and maintain a program to achieve its objectives. These must involve:

- Responsibility to achieve accepted objectives.
- Devices, means and a time-table to reach these objectives.
- Appoint a person who will continually give news to top management.
- Train all employees, if their work has environmental impacts.
- Keep (run) all necessary documents.
- Monitor and measure activities which have important impacts on the environment.
- Make periodic audits of the system of environmental management.

Starting point

Organizations which do not introduce a system of environmental management, must firstly make a review of their activities:

1. Find out demands of laws and regulations.
2. Identify the most important environmental aspects.
3. Review their current products in environmental management.
4. Evaluate the results from investigating accidents which have occurred in the past.

For this review, it is possible to use discussions, direct control and measurement, results from previous audits, etc. It is necessary to deal with:

- Air emissions,
- Water emissions,
- Waste management,
- Contamination of soil,
- Use of raw materials and natural resources, etc.

It is also necessary to speculate about convenient procedures to liquidate their own products after their life-cycle. The program can involve steps such as: planning, development, production, marketing, liquidation.

Questions

1. Give some examples of contemporary activities which can negatively influence the life and activities of future generations.
2. Which countries have the biggest production of CO_2 emissions?
3. Explain the term: Carbon footprint.
4. Why is not electricity a pure source of energy with no emissions?
5. Water transport seems to be very friendly to the environment. However, researchers say that it is a big pollutant. Why?
6. How to improve long Supply chains so that they emit less pollutants?

14 Supply chain risk

Chapter objectives

- People generally consider risk in terms of unpleasant things that might happen.
- In the context of supply chains, managers face the risk that a delivery is delayed, fuel prices increase, a project goes over-budget, a truck has an accident, a warehouse is destroyed by fire, and so on.
- Risk management is the process for systematically identifying, analysing and responding to risks throughout an organisation. Managers must be prepared to manage risk efficiently.

14.1 Definitions and forms of risks

Risk to a supply chain is any threat of an event that might disrupt normal flows of materials or stop things happening as planned.
Risk is the chance that an event might happen – it is not the event itself. Risks occur because we can never know exactly what will happen in the future. We can use the best forecasts and do every possible analysis, but there is always uncertainty about future events.

Risks come in many different forms. They can interrupt the supply of materials or the demand for products, they can cause a sudden peak in demand, or collapses. Their effects can range from the short term and lasting only a few minutes through to permanent damage, their effects might be localised in one part of the supply chain or threaten the whole chain. We can identify two basic kinds of risk to a supply chain – external and internal risks.

EXTERNAL RISKS – come outside the supply chain, such as earthquakes, hurricanes, industrial action, wars, terrorists' attacks, outbreaks of deceases, price rises, problems with trading partners, shortage of raw materials, crime, financial irregularities and so on.

It can be illustrated by the earthquake that damaged the Japanese city of Kobe, because it concerns also a significant part of the world's electronic industry that was situated nearby.
These risks are outside the manager's control. Managers cannot change the risk but can only design operations as effectively as possible within a risky environment. For example, by constructing secure buildings in regions with hurricanes or moving to another location.

INTERNAL RISKS – appear in normal supply chain operations, such as late deliveries, excess stock, poor forecasts, financial risks, human error, faults of information technology systems and so on.
These internal risks are generally less dramatic but more widespread in their effects. Managers can control them – delays and breakdowns and there are traditional ways of dealing with them.

For example, risks from suppliers can be avoided by multiple sourcing. Similarly, risks of the flow of materials are reduced by holding stocks – but there is the increase of costs. In reality, most risks are fairly minor and have limited consequences.

RISK MANAGEMENT is the process for systematically identifying, analysing and responding to risks throughout an organisation. Risk management is not new idea and it is the standard work of insurance companies and banks, but in recent years risk management has expanded from its traditional home in finance to the supply chain.

14.2 Risk management

CORE ELEMENTS OF RISK MANAGEMENT

1. Identify risks to the supply chain.
2. Analyse the risk – consider potential impact. This impact depends on two factors – the probability that a risky event may occur and the severity of the consequences when it does occur.

   Managers can prioritise risks according to their impact and decide where to concentrate resources.
3. Design appropriate responses to the risk. There are many types of response but three common ones are:
   - prevention – (to reduce the probability of a risky event occurring),

– mitigation – (to reduce the consequences),

– response – waiting to evaluate actual events before deciding on a response.

IDENTIFYING RISKS

It has been mentioned that risks can be either external or internal. A more detailed list suggests other possible risks to a supply chain:

- Political – such as government instability, regulations, customs barriers, etc.
- Economic – interest rates, inflation, taxes
- Physical – traffic accidents, equipment failure, congestion, limited capacity
- Supply – all issues with the movement of materials into an organisation (constraints, supplier reliability, lead times, material costs, delays)
- Transport
- Information – availability of data, transfer, accuracy, security of systems
- Organisation – its structure, subcontractors, communication flows, culture
- Management – their knowledge, skills, experience
- Planning – poor forecasting, lack of synchronization
- Human – interactions between people, aims, human errors
- Technical – new technology in processes, reliability
- Environment – pollution, traffic, regulations.

Having prepared a register of the most significant risks, the next stage is to analyse them more carefully, give each a priority and identify the most pressing. This analysis is based on two factors.

1. The likelihood of risky event occurring.
2. The consequences when the event does occur.

From these two factors we can calculate an expected value for each risk:
Expected value of an event = probability * consequence
When there is a 20% chance that a delivery is delayed, and any delivery costs 12 000 USD, then
Expected value of a delay = 0.2 * 12 000 = 2 400 USD

Problem:
Many people suggest that the probabilities of such risky events and value consequences can never be more than informed guesses. But we can make some simplifications. Rather than using a specific value for a probability, we can classify the likelihood as:

- Very unlikely – this event might only rarely happen, most people will never meet it.
- Rare – occasional event, might be expected 1–2x during the working life.
- Occasional – people meet it sporadically throughout their working lives.
- Frequent – event occurs regularly, people commonly meet it.
- Very likely – event occurs often, people meet it continuously and accept it as normal.

Impact of risks can be described as:

- Negligible – insignificant effect on the Supply chain.
- Minor – minor disruptions, delays, increased costs to some parts of the chain, but most functions are unaffected.
- Moderate – some disruptions on parts of the SC, but the main functions continue to meet requirements.
- Serious – major disruptions to the essential operations of the SC, causing serious delays and high cost of recovery.
- Critical – failure of the whole SC for an extended time, with major cost and effort needed for recovery.
- Catastrophic – causing complete and unrecoverable failure of the SC and possibly whole organisations.

Managers should clearly give highest priority to the most significant risks – which are those with the combination of highest probability and greatest consequence. Here the method ABC can help us to describe different categories of risk. Then we can classify risks as:

- A risk, the most severe that need special attention.
- B risks, the medium ones that need normal attention.
- C risks, the low ones that need little attention.

A formal presentation of the relative risks is a probability – impact matrix.

Table 14.1 The structure of a probability-impact matrix

		Potential consequence					
		Negligible	Minor	Moderate	Serious	Critical	Cata-strophic
Probability	Very high	B	B	A	A	A	A
	High	B	B	B	B	A	A
	Medium	C	B	B	B	A	A
	Low	C	C	B	B	A	A
	Very low	C	C	C	B	B	A

Source: adjusted by Waters (2009)

Dealing with risk

When we have different categories of risk, we can concentrate on the most important and design an effective response. The most common are:

1. Ignore or accept the risk – this means that the likelihood of the risk occurring is small and its consequences are minor, so managers can ignore it.

2. Reduce the probability of the risk – taking actions to reduce the chance that a risky event occurs. For example, when driving on long distance by a car, avoid the most dangerous areas (cities).

3. Reduce or limit the consequences – so that when the risky event occurs it is less harmful.

   (Car seat belts do not necessarily reduce the probability of an accident, but they can reduce the effects on people involved.

4. Transfer, share the risk – move some or all of the risk from one organisation in the supply chain to another that is more able or willing to handle it (insurance company).

5. Make contingency plans – managers take no immediate action, but they plan what to do if a risky event actually occurs.

6. Adapt to it – accept that a risky event is inevitable and try to adapt operations to fit into the new circumstances.

7. Oppose a change – when managers get prior notice that an event is going to happen, such as a government announcing that it will introduce new regulations at some point in the future, they can actively resist the change and try to prevent it happening.

8. Move to another environment – when some events are so risky that an organisation cannot work with them – move to another market that does not have the risk.

14.3 Results of own investigation of risks

(Vaněček, Kubecová), 2014

Table 14.2 Number of investigated firms and their specialisation

Household goods	19
Retail	22
Food processing	18
Engineering	33
Agriculture	9
Total	101

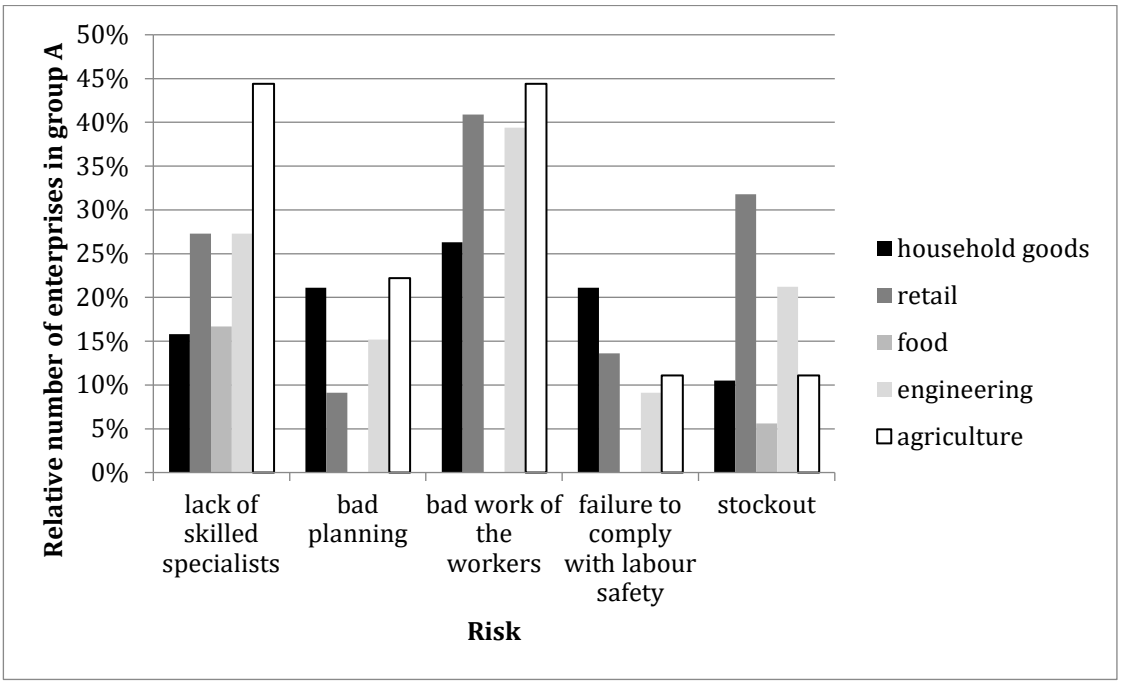
Table 14.3 Number of firms – Classification by probability – impact matrix

Risk (category A, B, C; 0 = no answer)	**A**	**B**	**C**	**0**
Natural hazard				
The risk of large floods	11	33	49	8
The risk of drought	11	14	59	17
Other natural hazard	4	14	12	71
Internal risk				
The risk arising from high interest rates	7	53	37	4
The risk of impossibility (difficulty) to get a loan	11	40	45	5
The risk of crime (theft, fraud, vandalism, copying products, etc.)	19	54	27	1
The risk of unexpected measures by national or regional authorities	16	49	31	5
The risk of inability to implement the directives, EU regulations (emissions, etc.) and suffer the consequences	9	58	30	4
The risk of price increase in raw materials and fuels	52	44	4	1
The risk of failures or intentional hindering of the information system	21	45	27	8
Partners				
The risk of increasing competition	55	38	8	0
The risk of unexpected measures from the parent enterprise	9	16	36	40
The risk of possible loss of an important partner	37	45	16	3
The risk of deficiency (loss) of customers	62	29	9	1

Risk (category A, B, C; 0 = no answer)	**A**	**B**	**C**	**0**
The risk of late payment (or non-payment) from customers	43	46	11	1
The risk of wrong selection of suppliers (and their poor activities)	19	61	21	0
The risk of negative impacts of a key link in the chain	15	50	24	12
The risk of court trials with customers	2	40	52	7
Enterprise				
The risk due to strategic (long-term) decision	23	57	21	0
The risk associated with entering new markets	11	48	32	10
The risk of failure to obtain grants, contracts	19	30	37	15
The risk of introduction of new working methods or production processes (unfulfilled expectations)	14	51	29	7
The risk of disorders of the production system	29	53	17	2
The risk of non-compliance with required quality of products (services)	40	47	14	0
The risk of a large debt, inability to pay the obligations	28	45	25	3
The risk of inability to consistently apply the technical progress	10	49	38	4
The risk of obsolescence of inventories	9	42	47	3
The family risk (small enterprises) there is not a successor; frequent conflicts.	15	21	41	24
Processes				
The risk of a lack of skilled workers	25	54	21	1
The risk of bad planning (overproduction, lack of product or service capacity)	13	65	21	2
The risk of poor work of staff	31	59	11	0
The risk of safety (accidents, fires, leaks of dangerous substances)	11	53	37	0
The risk of stocks and the inability to satisfy customers on time	18	56	24	3

Own source

Figure 14.1 Enterprises that see partner´s risk as important



Source: authors

Conclusions

The overall risk assessment by the sample enterprises is based on two aspects: the probability of risk and the assessment of its impact. This approach allowed the classification of all answers by the probability – impact matrix.

Answers displaying high (important) risk with critical and catastrophic impact were classified as group A. In this group, enterprises are afraid of the following risks:
The risk of loss of customers (62 enterprises).
The risk of increasing competition (55).
The risk of price increase in raw materials and fuels (52).
The risk of late payment from customers (43).
The risk of non-compliance with required quality of products and services (40).

Group C represents the other end of the assessment by the probability – impact matrix. The types of risk classified into this group are seen as minor or negligible.
The following types of risk occurred in this group:
The risk of extreme drought (59 enterprises).
The risk of court trials with customers (52).
The risk of large floods (49).
The risk of obsolescence of inventories (47).
The risk of impossibility to get a loan (45).
The family risk if there is not a successor or in case of frequent conflicts (41).

Enterprises with household goods see the following types of risk as the most important:
The risk of loss of customers (79%).
The risk of delayed payment from customers (58%).
The risk of large loss (53%).

Retail enterprises see the following types of risk as the most important:
The risk of loss of customers (64%).
The risk of price increase in raw materials and fuels (59%).
The risk of increasing competition (59%).

Food producing enterprises see the following types of risk as the most important:
The risk of price increase in raw materials and fuels (67%).
The risk of loss of customers (67%).
The risk of increasing competition (50%).

Engineering enterprises see the following types of risk as the most important:
The risk of increasing competition (63%).
The risk of loss of customers (58%).
The risk of non-compliance with required quality (55%).

Agricultural enterprises see the following types of risk as the most important:
The risk of extreme drought (78%).
The risk of price increase in raw materials and fuels (56%).
The risk of a lack of skilled workers (44%).
The risk of inability to implement the EU directives (44%).
The risk of floods (44%).
The risk of poor work of the staff (44%).

Obviously, the agricultural enterprises cannot be compared to other production types. Agricultural enterprises are seen as a separate group within risk assessment.

Questions

1. Characterize the difference between Risk and Crisis.
2. Present some examples of external and internal risk.
3. How can risk be managed in the firm?
4. What is the likelihood and the consequence of each risk?
5. Explain the way of using the ABC method in Risk management.

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Vydání:	**1. vydání, 2017**
Účel:	**Vysokoškolská učebnice**
Počet stran:	**167**
Elektronická verze:	**http://omp.ef.jcu.cz**

Tato publikace neprošla jazykovou úpravou v redakci nakladatelství.
Za věcnou a jazykovou správnost díla odpovídají autoři.

ISBN 978-80-7394-631-9