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LIFE CYCLE MANAGEMENT IN SUPPLY CHAINS

INTEGRATING ENVIRONMENTAL LIFE CYCLE THINKING INTO SUPPLY CHAIN MANAGEMENT

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INTRODUCTION

Due to increasing population, standard of living and consequently increasing human activities and production, environmental concern is gaining importance. It is becoming clear that our planet can not restore itself anymore and that resources are used unsustainably (Obrecht and Knez 2017). As human activities cause severe harmful local and global environmental impacts, our activities are increasingly beginning to consider environmental aspects. It is believed that environmentally conscious and more sustainable oriented operation may give organizations a competitive advantage especially on a long run (Plouffe et al. 2011; Albino et al. 2009; Dangelico et al. 2017; Gerstlberger et al. 2014).

Numerous facts revealed that current linear economy is unsustainable. Population growth and increasing standard of living require ever increasing material extraction, food, water and energy use. Consequently prices of these materials are increasing, arable land and forest areas are disappearing, accessible clean water is questionable on a long term, biodiversity is changing rapidly etc. (The 2030 Water Resource Group 2009; Alexandratos in Bruinsma 2012; International Energy Agency 2017). Due to forecasted trends environmentally sound economy such as circular economy, life cycle based ecodesign and sustainable supply chains will become not just a part of comparative advantage in achieving differentiation strategy but also a possible potential answer to forecasted socio-economic challenges in the forthcoming decades (Bešter 2017) and a systematic solution for sustainable existence of human kind (Širec et al. 2018).

However concentrating on environmental perspective solely in one part of the supply chain (SC) is not sufficient for efficient improvements because environmental impacts are caused through the whole SC, from raw material extraction, production of materials and components, manufacturing final product, its distribution, use and end-of-life. Literature review suggests that environmental goals e.g. 20/20/20 objectives set by the EU can not be achieved only through inter-organizational activities and measures but in cooperation along entire value chain taking advantage of chain synergies among supply chain participants (Szegedi et al. 2017). Therefore also environmental management schemes (e.g. ISO 14001 or EMAS) include cooperation of different actors within the whole SC. Complexity of sustainable SC, circular economy as well as ecodesign require cooperation of different stakeholders on different levels, therefore systematic approach is inevitable. Companies's managers must become aware that

economic and environmental goals are not contradictory to each other but can be achieved simultaneously (Preston 2012; Lieder in Rashid 2016; Ghisellini et al. 2016).

The idea of environmentally conscious (green) supply chain management (SCM) first began to take root in technical literature in the early 1970s. The integration of the disciplines of both the green operation and the complex SC (including purchasing, production and logistics) came into focus in the 1990s especially in automotive sector (Szegedi et al 2017). Many organizations still have a very narrow perception of their environmental impact, which is mostly limited to site-specific production activities (Ammenberg and Sundin 2005). Contrary to this, one of the major trends of sustainability programs in industrialized countries is so called life cycle thinking, which expands the focus from the production site to incorporate various economic, environmental and social aspects associated with a product over its whole life cycle (UNEP 2006). Life cycle thinking is based on the principles of pollution prevention, in which environmental impacts are reduced at the source, and on closing the loop of materials and energy (European Commission 2014). Namely, all products and services have some impact on the environment which may occur at any or all phases of the product's life cycle including raw materials extraction, manufacture, distribution, use and waste disposal (Denac et al. 2018). Companies with a higher developed traditional SC have also a more developed green supply chain management (GSCM) system (Szegedi et al 2017).

Strong indications also confirmed that commitment to ecodesign and sustainable development within organization seems to be the most important issue for improvements and environmental labels a strong tool for communicating with customers (especially green oriented). Company managers are always interested to achieve business benefits simultaneously with environmental improvements and environmental labels are a potent tool for achieving just that. On one hand improving company's image, gaining new green oriented consumers, being able to compete on green public tenders, differentiate on a highly competitive market, decrease fees for waste or use of hazardous materials etc. and on the other hand benefit from environmental improvement also directly within the company walls - e.g. decreased material or energy use, decreased amount of wastes, increased efficiency, smaller water consumption.

The goal of the chapter is therefore to get better insight on greening of supply chains, raise importance of life cycle thinking for supply chain managers and to study and discuss the use of different methodologies, principles and tools like life cycle impact assessment, eco-design

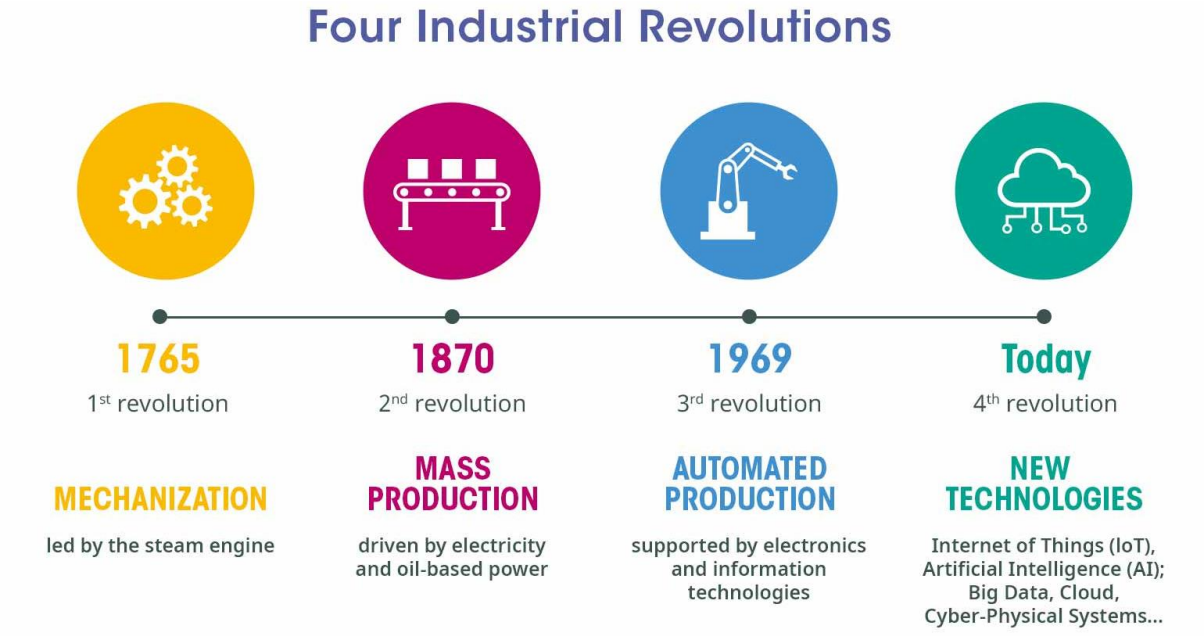
and environmental labels within supply chain management. Case studies of best practices on life cycle assessment and eco-design are therefore presented to consolidate the knowledge on environmental issues and to integrate it within supply chain management. Comprehensive collection of such tools, principles and methods as well as cases of solving actual problems is crucial for supply chain managers to enable them better understanding and importance of environmentally sound business models and emphasises sustainable development also for companies.

1 SUPPLY CHAIN MANAGEMENT

1.1 History of Supply Chain development

Businesses operate in order to meet the unlimited needs of humankind, add value to community and get into profit. Over the centuries, there have been several breaking points in business world and industrial revolutions have been realized. It is possible to divide industrial revolutions into four groups amongst themselves. In today's technological, abruptly changing world. Industry 4.0 or the Fourth Industry Revolution is on the horizon. Development from 1st industrial revolution to Industry 4.0 is presented on figure 1.

Figure 1: Industrial revolutions



Source: Sanofi, VisiaTIV Industry, n.d.

Prior to that supply chain management started to develop with the first industrial revolution starting in Great Britain in 1750. The first Industrial Revolution was a cultural and economic shift from cottage industry, traditional agriculture and manual labour to system of factory-based manufacturing that included complex machinery, continual technological growth, new energy resources and technologies such as steam-driven machines and developments in transportation like coal-fired and faster but environmentally unfriendly ships and trains. The textile industry

and steam power led the way. These increased demand for textile fabrics mainly from former Great Britain colonies and started a process of globalization. At that time more companies started to work together in production of a single item (farmers and cotton producer in colonies, textile companies in colonies supplying producers in Great Britain with raw material, retailers selling clothes etc. Steam power also enabled new transport means (turnpike, railways, steamers etc.) that were much faster and not dependent from weather conditions but also environmentally disputable.

Second Industrial Revolution that followed focused on mass production and was driven by oil-based power and electricity, enabling development of technology and society. Automobiles and airplanes started to rule in supply chain transport and mass production required new supply chain models enabling sufficient supply for the production of all goods.

3rd industrial revolution can be identified with automatization in production supported with sensors, IT and electronics. Just in time delivery is becoming more and more important and raw materials are becoming scarce and expensive, therefore supply chain must become more efficient and flexible.

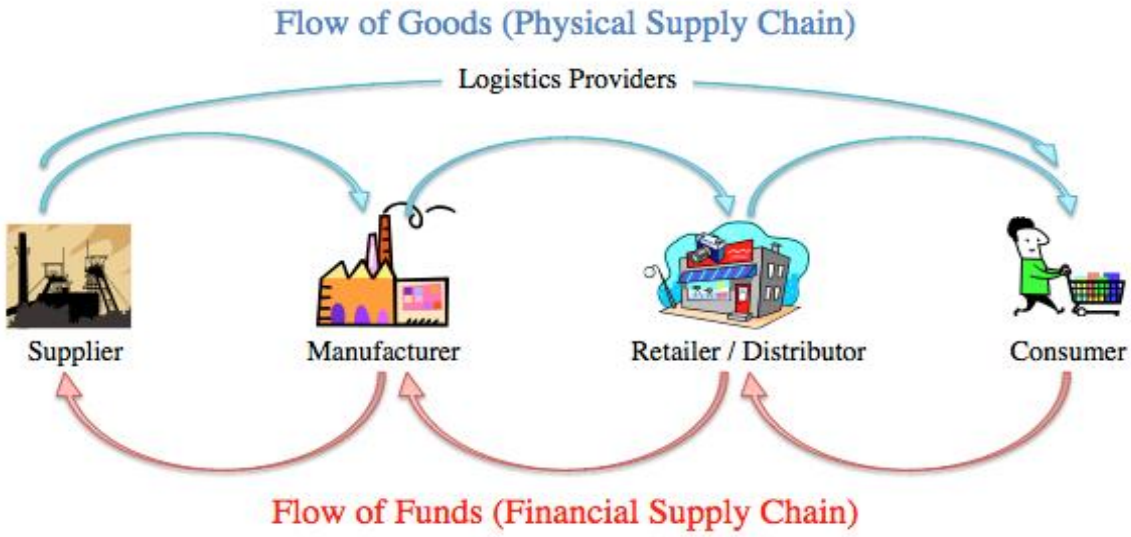
However today we witness development of "Industry 4.0", establishing a hyper-connectivity that goes beyond the factory walls and where production means interact not only with the factory environment itself but along the value and supply chain which customers, suppliers and so forth. It is increasingly blurring the boundaries between the real and virtual world towards cyber-physical production systems (Deloitte, 2014). In today's digitalising world, companies have been investing to their own digital infrastructure in order to keep up with the competitive environment in logistics and supply chain, as well. Industry 4.0 ecosystem will be based on full implementation of a wide range of digital technologies- the cloud, big data and data mining, The Internet of Things, 3D Printing, augmented reality and others (Schrauff and Berttram, 2016). When traditional supply chains rely on a mix of electronic and paper-based processes and documentation, these activities will vanish in industry 4.0. in matter of years.

1.2 The Term "Supply Chain"

The term "Supply Chain" is very broad concept and can be defined in many different ways. A supply chain consist of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers and even customers themselves (Chopra and Meindl, 2007). According to this definition, supply chain covers purchasing or procurement activities, input logistics operations, manufacturing and production, warehouse and distribution planning and execution, delivering semi-finished and final products to eventual customers and reverse logistics approach. In other words, supply chain is a system of organizations, people, activities, information and resources involved in moving a product or service from supplier to customer. Supply chain activities involve the transportation of natural resources -such as petroleum, natural gases wind-, raw materials and components into a finished product that is delivered to the end customer (Supply Chain, n.d.; Chopra and Meindl, 2007). There are four, main major players in supply chains listed below:

- Suppliers and Vendors
- Manufacturers
- Distributors
- End users or end customers/consumer. In turn, these major players will be explained

Figure 2: The Flow of Goods and Funds in a Supply Chain



Source: CTM, n.d.

1.1.1. Suppliers

Supplier is a name given to the supply chain partner who provides required materials like raw materials, semi-finished goods, components, packaging materials and so forth to the manufacturing firms in order to produce their own products and meet customer requirements. Suppliers must understand the changing needs of the day and transform rapidly, deliver the whole materials on required date and in a quality way. The more, suppliers provides all necessary materials to the firms at an affordable or accessible price and with demanded quality, the more they will be preferred by the manufacturers/buyers and the more profit they gain.

The key for suppliers to be successful is to carry out above-mentioned elements. When we examine the supply chain environment in one company, there are almost always not just one or two but plenty of suppliers and manufacturers. Therefore, the main question is which supplier will be chosen by which company and which criterion will play key role? These criterions were set by companies to make the best and ideal decision and are as follows (based on Borowska, 2016 and Corrigan, 2018):

- Cost
- Quality & Safety
- Delivery times
- Service level
- Social responsibility
- Convenience/Simplicity
- Risk & Agility
- Compliance with local law
- Avoid conflict of interests and new, emerging criterion
- Supplier's environmental performance

It is almost impossible to fulfil all above mentioned elements, therefore suppliers have to focus on most important criterions and try to specialize in them.

As shown in the Figure 2, both suppliers and manufacturers must be in close relations and collaboration with logistics providers and transport operators. If transport operators and logistics service providers are not included in this system and in close relationships is not established, goods cannot be transported from the point of origin to the point of production and

from there to the point of consumption at required time and planned costs. I can be even concluded that all partners of a supply chain have the same importance in the supply chain.

Suppliers are the first part of the supply chain. All materials are picked at the point of supplier and dispersed to different points and sites. Therefore they have a hugely important role at every stage of the product lifecycle, especially when considering environmental impacts of embodied materials and embodied energy in final product or service. From sourcing raw materials to helping ramp up production and to finding better sollutions for raw materials as the market starts becoming saturated, companies need to work closely with their suppliers to get the best out of their products (Corrigan, 2018).

1.1.2. ***Manufacturers***

A manufacturer is someone who is in charge of manufacturing and designing a product or by using materials that were purchased and delivered by suppliers with the objective of selling this related goods to the other major players of a supply chain. Manufactured products made by the manufacturing industries can be divided into two major classes; consumer goods and capital goods.

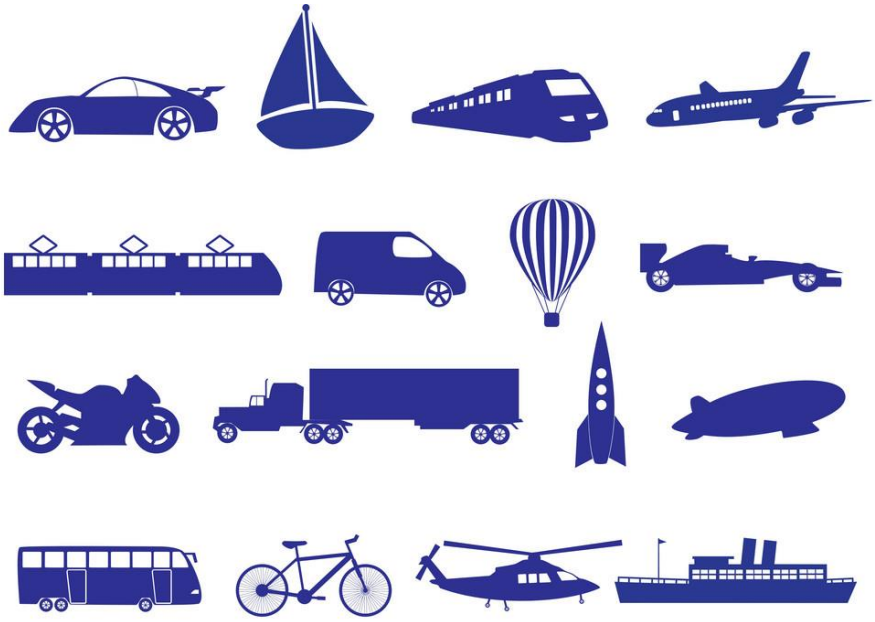
Consumer goods are products purchased directly by consumers, such as cars, personal computers, televisions and so on. It is not the case that these goods are sold for commercial purposes.

Capital goods are goods purchased by companies to produce goods or/and provide services. Examples of capital goods include aircraft, computers (used for commercial and productive aims), communication equipment, medical apparatus, trucks and buses, railroad locomotives, machine tools and construction equipment (Groover, 2010).

Most of the goods, that are used in supply chain until the delivery of eventual goods to the customers, are capital goods. Those related to transport are presented on Figure 3. By using capital goods, business aims to create value-adding services and increase their market shares and profitability in today's global, competitive and abruptly-changing world.

Manufacturing is the value added to production of merchandise for use or sale using labour and machines, tools, chemical and biological processing or formulation (Chopra and Meindl, 2007). Recently we can refer to manufacturing also as a combination of human and machine interaction. While people in the production process are adding their rational skills and their creativity, machines contributes for serial production and perform heavy work.

Figure 3: Capital Goods in Logistics and Transport sector



Source: VectorStock, n.d.

1.1.3. Distributors

A distributor, who informs retailers and industrial customers about company's product, assumes the responsibility of product distributor functions, works in contract with a company and encourage new candidates for distributorship activities. Distributor assists customers in purchasing the goods and services company and gets a certain margin for this service. Distributor's added value is usually its own organizational network. In today's world, the concepts of "trade agent" and distributor are mixed. As an activity, distributors first purchase goods and resell them to local retailers or consumers. So they take title of the goods. The ownership of the good belongs to distributor prior to selling. In addition they can sell its products to the wholesalers. When we compare the revenue models of trade agents and distributors, distributors add a margin on the products' prices and the agent are paid by the supplier through a commission on the sales value generated. In terms of holding inventory, distributors take care of inventory management (Salzano, 2014).

But another important issue as significant as selecting distributors and trade agents in the supply chain management is the choice of the best and optimum distribution channel. While

making a decision for a distribution channel, according to Chand (2019) supply chain managers have to consider;

- Product' specifics
- Markets
- Middlemen – particularly, it is required to solve problems or prevent some conflicts in the supply chain
- The size of a company
- The marketing structure and environment of a market
- Competitors on the market
- Customer Characteristics and Purchasing Habits
- Possible Channel Compensation in case of disruptions.

1.1.4 End Consumers

End consumers are also members of the supply chain who use what they buy from retailers to meet their daily and personal requirements. In a supply chain management practice it was long practiced that end customers form the last ring. The purpose of all members or partners within the supply chain is to provide goods and services to end customers at the highest quality, at the shortest possible time, with affordable prices and at requested quantity. At this point, retailers have been taking responsibilities in understanding the needs and requirements of end customers, however to avoid "bullwhip effect" retailers have to cooperate with manufacturers and suppliers to plan their sales and to enable sufficient product availability.

Retailers can also be identified as being "consumers" of large manufacturers sometimes. They are the one that are able to communicate face to face with consumers, can observe their requirements and desires, are more advantageous compared to other members of supply chain in this regard and have to analyse changes in customer behaviour, requests and demand. If retailers perform their job successfully and cooperate with other supply chain members, supply chain can adapt successfully to any changes in the fast changing business environment. The key for success in today's competitive global and local market environment is to be able to foresee the demands of customers and to determine the supply chain strategies according to this changings.

1.1.4 Reverse logistics and waste management

Most of the authors investigating supply chain management typically identified end users as the last part of the supply chain as already mentioned in subchapter 1.1.4. However due to lack of scarce materials, increased energy and raw material prices, challenge of guaranteed procurement quantities and increasing amount of wastes created and environmental problems related with that, companies and countries have seen that they have to look for raw materials also at the end of supply chain. Wastes are no longer seen just as wastes but in terms of circular economy also as a valuable resource for future business activities within the company that created them or as an additional revenue opportunity if these is sold to another organisation interested in it. This affected supply chains and transformed them into supply chain with closed loops or in most ideal case in circular structures. New business models, business processes and new transport routes were therefore added to classical supply chain, to direct flow of goods from end customers or waste managers back to manufacturers, recyclers, energy providers or even suppliers instead of landfilling them.

1.3 Supply Chain Management Development

In 1997 Marshall Fisher introduced the revolutionary concept of supply chain segmentation in his famous article "What is the right supply chain for your product?" (Fisher, 1997). Following Fisher's article, several academics and consultants developed several models regarding the formulation of supply chain strategy.

The concept of supply chain management is based on two core ideas. The first is that practically every product that reaches an end user represents the cumulative effort of multiple organizations. These organizations are referred to collectively as the supply chain. The second idea is that while supply chains have existed for a long time, most organizations have only paid attention to what was happening within their "four walls".

Supply chain management, then, is the active management of supply chain management activities to maximize customer value at the end of supply chain and can be upgraded into sustainable supply chain management when sustainable competitive advantage within the supply chain is also achieved or is a part of added value detected by customers. It represents a conscious effort of all supply chain members to develop and run supply chains in the most effective and efficient ways possible (Chopra and Meindl, 2007; Christopher, 2016).

One key to of managing the supply chain is to have an explicit knowledge and understanding of how the supply chain network structure is configured. When determining the network structure, it is necessary to identify who the members the supply chain are (Lambert et al., 1998).

Here two different approaches for supply chain determination are presented. Croxton et al. (2001) examined supply chain activities and its structure in eight processes that can be identified as the core activities of supply chain management:

1. Customer Relationship Management(C.R.M.)
2. Customer Service Management
3. Demand Management

Predicting future demand, evaluate needs for production, sales etc.

4. Order Fulfilment

Timely delivery, with the lowest cost

5. Manufacturing Flow Management

Commercial and financial flow from the point of origin to the point of consumption including reverse logistics activities-

6. Procurement

Material, energy, service procurement for successful SC operation

7. Product Development and commercialization

From the design of products to innovative, value added, supplementary services.

8. Returns (reverse logistics)

Balou (2007) and Cristopher (2016) identified slightly different framework to follow to achieve successful management of supply chains, related more on general (and specific) business management activities, not just on supply chain activities. It can be divided on:

1. Planning

The most important stage - before the beginning of the entire supply chain, it is essential to finalize the strategies and implement it (Checking product demand, viability, costing, profit, manpower etc. Without a proper plan or strategy in place, it will be impossible for to achieve effective and long term benefits. Planning helps to identify the demand and supply trends in the market and this, in turn, helps to create a successful supply chain management system.

2. Information

The world today is dominated by a continuous flow of information and business must be aware of new business trends, production aspects, delivery times, demand level etc.

3. Material sourcing

Suppliers play a crucial role in supply chain management since they supply different sets of raw materials. These must be of high quality, environmentally undisputable, socially responsible etc. If a supplier is unable to supply on time, and within the stipulated budget. If the material is environmentally unfriendly it might not be useful for production in a company that uses environmental labels and environmental management scheme. If the product is socially irresponsible, company might suffer losses and gain negative reputation since more and more customers demand socially responsible products.

4. Inventory

Inventory management is critical to the operability of supply chains. Without proper inventory the production, as well as the sale of the product is not possible. However because inventory holding represents high costs for supply chain members, inventory should be as limited as possible for normal SC functioning.

5. Production

It is only possible when all the other components of the supply chain are in tandem with each other (proper planning, inventory, sourcing etc.). The production is followed by testing, packaging and the final preparation for delivery.

6. Location

Location selection is of core importance. E.g. brewery must be position in the region with high water supply since water is most important ingredient for beer production. It is also important that grains, barley etc. are available in the region to reduce transportation costs.

7. Transportation

Transportation is vital and can be cost intensive, must ensure zero damage/minimal loss and on time delivery. Due to increasing environmental awareness and stricter legislation, companies are nowadays more and more interested for sustainable transport modes.

8. Return of goods

Facility to return the goods in case of failure. Recently also to follow circular economy principle and return goods after the end-of-life, not just in case of failure.

Chopra and Meindl (2007), also leading researchers of supply chain management, defined common drivers of all supply chains to be somehow different. They are presented on Figure 4

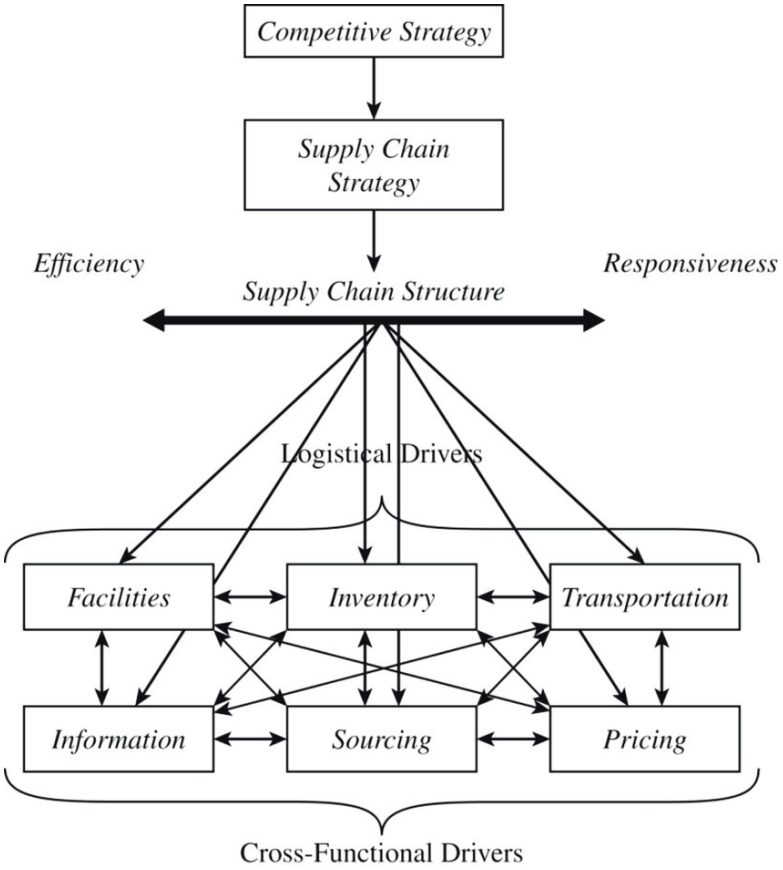
1. Facilities

Actual physical locations in supply chain network where product is fabricated, assembled, stored. Decisions regarding the role, location capacity and flexibility of facilities have significant impact on supply chain performance. Honda and Toyota always tend to have manufacturing facilities on all of their biggest markets to be more responsive to their customers and to avoid possible legislative obstacles on imported goods. If the response time is low company does not need so many facilities.

2. Inventory

Includes all raw materials, semi-finished and finished goods within the supply chain. A retailer can become more responsive if it increases inventory and satisfying customer demand for stocked items, however it increases inventory holding costs. Inventory is related also with facilities and costs – more facilities means more inventory holding costs because each facility needs certain amount of stocks.

Figure 4: Supply chain decision making framework



Source: Chopra and Meindl, 2007

3. Transportation

Means moving inventory through the supply chain and can be a combination of different transport modes and routes. Air transport increases responsiveness but it is also very expensive compared to

maritime transport and is therefore appropriate for items that customers want to get very fast and are ready to pay the fee for it.

4. Information

All data on facilities, inventory, transportation, costs, prices, customers in the whole supply chain. It represents a basis and an opportunity for efficient actions on supply chain management. E.g. customer demand information are becoming more and more relevant to plan sufficient production and to decrease stocked items and inventory holding costs.

5. Sourcing

Choice and dilemma who will perform particular activity in the supply chain. Will an organisation do something by themselves or will they outsource particular activity, maybe decide for 3PL or even 4PL covering the whole supply chain management by external professionals.

6. Pricing

Company must determine how much they will charge for goods or services they provide in a supply chain. Pricing affects buyers behaviour. Customer that value efficiency will usually order early to compensate the time lost with e.g. low-cost maritime transport. Early orders are also likely if price vary with lead time.

It can be seen from above described cases of supply chain management drivers that different authors focus on similar supply chain topics. Therefore these supply chain drivers must be taken into account when designing companies' supply chains and making strategic decisions on priorities related to flexibility and cost efficiency of the whole supply chain.

1.4 Supply Chain Management Strategies

According to above mentioned SCM activities and numerous partners cooperating within supply chains, it is necessary to establish a well-designed and well-thougt-out supply chain management strategy in order to enable enterprises to make supply chain effective and efficient. In order to create good supply chain strategy, executives who have been working in the field of supply chain, the strategists and planners of a business strive to make the best and optimal supply chain management strategy by working in collaboration. At this point, it is required to know and define all elements that form the basis of supply chain management strategies. According to Perez (2013) there are four elements that include the basis of supply chain management strategies and are as follows;

1) Industry Framework: Industry framework refers to the interaction of suppliers, customers, technological development and economic factors that affect competition in any industrial sector. Within this framework are four main drivers affecting supply chain design, all of them interrelated;

- Demand variation
- Market mediation costs
- Product life-cycle
- Relevance of the cost of assets to total cost

a) Demand Variation: Demand variation influences the stability and consistency of the manufacturing asset's workload;

b) Market Mediation Costs: Market mediation costs are cost associated with the imbalance of demand and supply. These costs, which reflect the unstable and fragile balance between lost sales and product obsolescence, arise from the consequences of the degree of demand predictability;

c) Product Life Cycle: Product life cycle, which is continually getting shorter in response to the speed of change in technology, fashion and consumer product trends, affects the predictability of demand and market mediation costs. It pushes to company to increase the speed of product development and to continuously renew their product portfolios;

2) Unique Value Proposal: The second element, unique value proposal requires a clear understanding of the organization's competitive positioning in terms of its supply chain;

3) Managerial Focus: This focus is the most important factor in ensuring coherence between supply chain execution and a business' unique value proposal;

4) Internal Processes: Internal processes, provides an orientation that ensures a proper connection and combination within the supply chain activities that fall under the categories of source, make and deliver.

In the past, customers were not as demanding and competition was not as intense as nowadays. As a result, firms could afford to ignore issues pertaining to the supply chain. Today, firms that do not manage their supply chain will incur huge inventory costs, lose a lot of customers because the right products are not available at the right place and time and will eventually collapse. The following are the five major business trends that have emerged to make supply chain management a critical success factor in most industries.

- ***Proliferation in product lines***. Companies have realized that more and more product variety is needed to satisfy the growing range of customer tastes and requirements. This is evident from the fact that every time a customer walks into a neighbourhood store, he or she is bound to discover a couple of items on the shelf that he or she had not seen during his or her last visit and that he or she has more varieties to choose from now.
- ***Shorter product life cycles***. With increased competition, product life cycles across all industries are becoming shorter. For example, the PC industry works with a life cycle as short as 6 months. So a firm like Dell, which has, on an average, just 7 days of inventory, as compared to the industry average of 35 days, does not have to worry about product and component obsolescence.
- ***Higher level of outsourcing***. Firms increasingly focus on their core activities and outsource non-core activities to other competent players. Michael Dell, the CEO of Dell Computers, had mentioned that if his company is vertically integrated, it would need five times as many employees and would suffer from a drag effect. Apart from primary activities in the value chain, even support activities that were usually done in-house are outsourced in a big way now.
- ***Shift in power structure in the chain***. In every industry, the entities closer to customers are becoming more powerful. With increasing competition, a steadily rising number of products are chasing the same retail shelf space. Retail shelf space has not increased at the page at which product variety has increased. So there have been cases of retailers asking for slotting allowance when manufacturers introduce new products in the market place.
- ***Globalization of manufacturing***. Over the past decade, tariff levels have come down significantly. Many companies are restructuring their production facilities to be a par with global standards. Unlike in the past, when firms use to source components, produce goods and sell them locally, now firms are integrating their supply chain for the entire world market.

Chopra and Meindl (2007) also developed a concept of strategic fit supply chain, meaning that a supply chain is well balanced among costs (efficiency) and time (responsiveness). To achieve strategic fit supply chain, organisation must be well aware of demand (customer and supply chain) uncertainties and supply chain capabilities. It must always consider customer needs that needs to be meet and the costs of meeting them. If demand is highly uncertain, inventory must

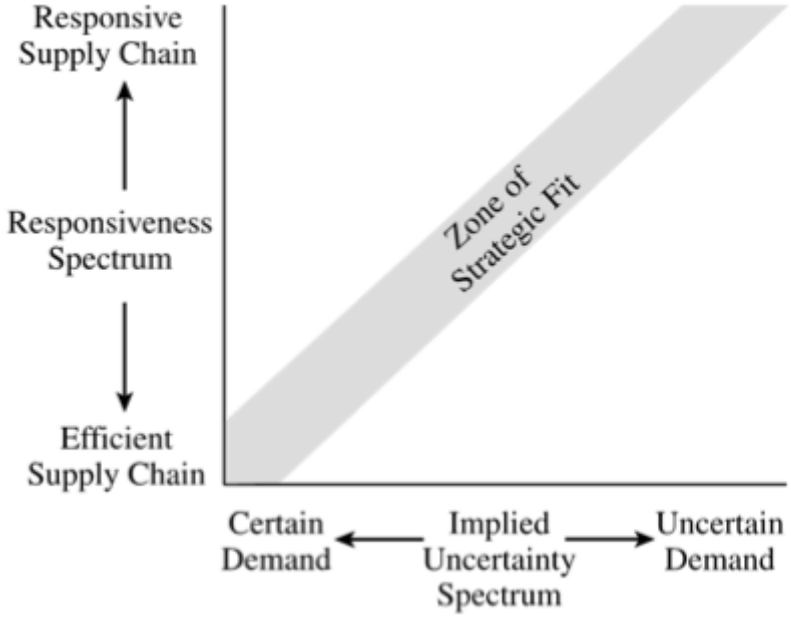
be kept low because risk of not be able to sell it is very high. On the other hand, company selling petrol needs to buy bigger amounts of petrol when the price of oil is low, because demand is relatively constant and not that flexible so they do not have to be afraid of not selling it.

Main dilemma of supply chain design is therefore whether to design it to be flexible and responsive or cost efficient. Strategic fit supply chain zone is presented also on Figure 5. Chopra and Meindl (2007) suggest that the company consider:

- the quantity of the product needed (in general in each lot, batch size etc.);
- the response time that customers are willing to tolerate;
- variety of products that are requested by the customers;
- the service level required;
- the price;
- rate of innovation.

If they get enough information about above mentioned topics, uncertainty of the demand (seasonal demand – e.g. winter jacket; one time event – e.g. Olympic games 2020, constant demand - petrol) and manage their supply chain capabilities (Can the demand be fulfilled in right quantities?; Is it possible to expand on the new market? Will we have sufficient production potential if we do?; Can we offer the right service level or do we need to employ more people? etc.). When designing supply chain strategy of efficient or responsive supply chain, pricing strategy, manufacturing strategy, inventory strategy, lead time strategy and supplier strategy are also being partly determined.

Figure 5: Strategic fit supply chain



Source: Chopra and Meindl, 2007

In can also be divided on two parts like in case of transport companies – fast transport requires additional fee but enables very fast delivery (e.g. different deliver options on Amazon). If there is no need to get the product in short period of time, customer can choose low cost delivery that decreases costs and increases time needed for delivery. When offering different possibilities more buyers can be covered but it is also more expensive for a company to have two different supply chain strategies.

CASE STUDY 1 – ZARA's SC strategy
Zara is a Spanish clothes and accessories brand (flagship brand of the Inditex group) that keeps up with the latest fashion, are of high quality and yet, affordable but not low cost. It is probably the amalgamation of all these qualities that made Zara, the Spanish clothing brand become the go-to fashion brand for all. Zara's story begins at 1963, when Amancio Ortega establish a company named Inditex (Industria de Diseño Textil). After 12 years Ortega opened its first Zara store in the centre of La Coruña, Spain. From 1988 when Zara became international, Zara now has over 7,490 stores strategically located in city centres in leading cities across 96 markets (Inditex, 2019). One of the most significant companies strengths is good SCM that becomes important success factor in fast fashion business. It deals with suppliers, with supplier's suppliers, with customers and sometimes even customer's customers. It looks at the process from raw materials origin to customer consumption. The output of supply chain is not just a

physical product, but a combination of time, place, form and function of a product/service proposition (Cai-feng, 2009).

They follow logistics and business trends, innovative (even though sometimes accused of might being copied) fashion, worldwide presence and focus on customer demands make them a market leader. Inditex's (so also Zara's) goal is to offer products of the *highest quality* to all its customers at the same time as striving to *develop a business that is sustainable*. All of Inditex's processes are inspired by and stem from our Code of Conduct. With this as a basis Zara has developed stringent product health and safety standards (Clear to Wear and Safe to Wear) as well as labour standards enshrined by the Code of Conduct for Manufacturers and Suppliers (Tested to Wear) and environmental sustainability standards (Green to Wear). These are the foundations of the Group's environmental and sustainable strategy. All of these standards are part of our effort to make products that are Right to Wear. (Inditex, 2019).

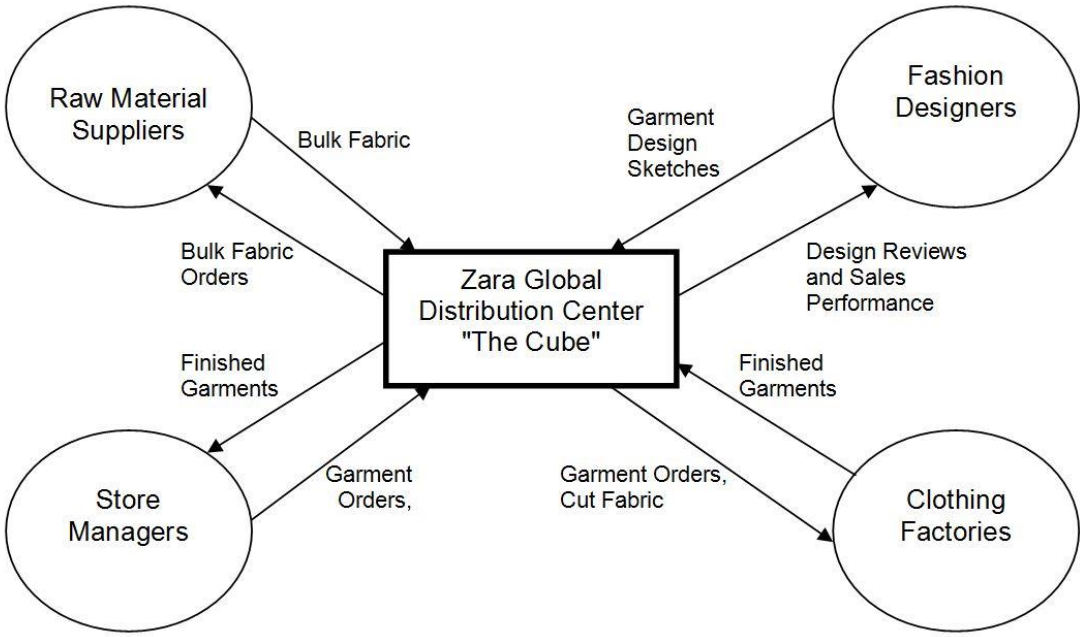
Low inventory strategy may seem like a very risky strategy, but in Zara's case it proved successful. Zara is changing its inventory very fast – they can launch (design, produce, distribute and position it in retail stores) new product in stores in just 10 days that means that they can offer new designs, new product lines each 14 days. However, their offer is always limited. Distribution in the EU enables them fast delivery in 24 hours and 48 hours in Asia (72 h in Japan) and USA. They use short, direct and standardized distribution channels that are managed by Zara directly. They do not use much of outsourcing since their managing capabilities would be decreased if they would use like 3PL ("third party logistics" that mean completely outsourced logistics). They have direct approach since they produce and sell clothes in their own retail shops. It this way they are again more responsive and keep all the margins for themselves (there is no sales provision). Zara practically do not have any inventory. Finished goods are being kept in their distribution centre (DC) for max. 1 day and DC is used only for distribution, not for storage.

Most of their production capacities are in Spain as well as main logistic centre in vicinity of the production. Distribution is organized daily across the globe. Supply of materials mainly from European suppliers, design and manufacturing organized almost "locally" (most in Spain, some in neighbour country Portugal and Morocco) and global distribution and sales enables them small inventory and fast responsiveness. Vertical integration and management of all

supply chain activities enable them core competitive advantage since they are much more responsive than their main competition (e.g. the same process in H&M takes app. 9 months, some other competitors 3 months) and therefore they are not forced to follow low cost strategy and can achieve higher margins. They have very wide product range since Zara carries about 11,000 distinct items per year in thousands of stores worldwide compared to competitors that carry 2,000 to 4,000 items per year in their stores. From a supply sense perspective, Zara's fast fashion operation obligates its in-house design and production teams to work with a limited set of pre-selected fabrics and materials. This may limit creative freedom, but it also eliminates months of lead time and tiers of supplier hand-offs from network. Awareness of capacity, cost, availability and lead time is therefore far better than for competitor, who distant supply bases in Asia or Latin America (O'Marah, 2016). Perhaps link to the fast product replacement and turnover makes customers think *"I need to buy this now, otherwise someone else will"*. They create fear of loosing something and Zara is artificially lowering its inventory. The idea is that low-inventories create a sense of urgency among customers. They think: *"I had better buy this dress because there are only two left*". While this amounts to something like a psychological ruse, low-inventories enable Zara to decrease the number of price reduction events ("sales").

Zara competes on flexibility and agility instead of low cost and cheap labour. They employ about 3,000 workers in manufacturing operations in Spain at an average cost of 8.00 EUR per hour compared to average labour cost in Asia of about 0.40 EUR per hour. Zara factories in Spain use flexible manufacturing systems for quick change over operations. 50% of all items are manufactured in Spain, 26% in the rest of Europe (mostly neighbouring Portugal) and 24% in Asia and Africa (mostly neighbouring Morocco). Zara buys large quantities of only a few types of fabric (just four or five types, but they can change from year to year), and does the garment design and related cutting and dyeing in-house. This way fabric manufacturers can make quick deliveries of bulk quantities of fabric directly to the Zara DC called "the Cube". The company purchases raw fabric from 1866 suppliers mainly located in Italy, Spain, Portugal and Greece. And those suppliers deliver within 5 days of orders being placed. Inbound logistics from suppliers are mostly by truck. The Cube is 464,500 square meters (5 million square feet), and highly automated with underground monorail links to 11 factories within a 16 km (10 mile) radius of the Cube. All raw materials pass through the cube and all finished goods also pass through on their way to stores. Diagram that illustrates Zara's supply chain model you can be seen on Figure 6. (SCM Globe, 2016)

Figure 6: Zara's distribution centre called » The cube«



Source: SCM globe. 2016

A little bit about how Zara's how the Zara supply chain is organized. You can see it on Figure 4. Manufacturing is centred in north-western Spain where company headquarters and the Cube are located. But for their main distribution and logistics hub they chose a more centrally located facility. That facility is located in Zaragoza in a large logistics hub developed by the Spanish government. Raw material is sent by suppliers to Zara's manufacturing centre. Then finished garments leave the Cube and are transported to the Zara logistics hub in Zaragoza. From there they are delivered to stores worldwide by truck and by plane. Zara can deliver garments to stores worldwide in a few days: China – 48 hrs; Europe – 24 hrs; Japan – 72 hrs; United States – 48 hrs. It uses trucks to deliver to stores in Europe and uses air freight to ship clothes to other markets. Zara can afford this increased shipping cost because it does not need to do much discounting of clothes and it also does not spend much money on advertising. (SCM Globe, 2016).

1.5 Key differences between Logistics Management and Supply Chain Management

Logistics typically refers to activities that occur within the boundaries of a single organization and supply chains refer to networks of companies that work together and coordinate their actions to deliver a product to the market. Also, traditional logistics focuses its attention on activities such as procurement, distribution, maintenance, and inventory management. Supply Chain Management (SCM) acknowledges all of traditional logistics and also includes activities such as marketing, new product development, finance, and customer service (Table 1.).

Table 1: Comparison of Logistics and Supply Chain Management

BASIS FOR COMPARISON	LOGISTICS MANAGEMENT	SUPPLY CHAIN MANAGEMENT
Meaning	The process of integrating the movement and maintenance of goods in and out the organization is Logistics.	The coordination and management of the supply chain activities among different parties within SC is known as Supply Chain Management.
Objective	Customer Satisfaction/Business success	Competitive Advantage
Evolution	The concept of Logistics has been evolved earlier.	Supply Chain Management is a modern concept.
Involved organizations	Typically one	Multiple organizations
One in another	Logistics Management is a fraction of Supply Chain Management.	Supply Chain Management is the new version of Logistics Management.

Source: Surbhi, 2015

Partnerships are becoming crucial for successful collaboration of material suppliers, producers, transporters, warehouses, distribution centres, retailers and reverse logistics companies enabling symbiotic business solutions.

The major differences between logistics and supply chain management can be described as:

- The flow and storage of goods inside and outside the firm is known as Logistics. The movement and integration of supply chain activities among SC partners is known as Supply Chain Management;
- The main aim of Logistics is to full customer satisfaction. Conversely, the main aim behind Supply Chain Management is to gain a substantial competitive advantage;
- In the modern world there is a competition among supply chains, not individual companies;
- There is usually only one organization involved in Logistics while some organizations are involved in Supply Chain Management;
- Supply Chain Management is relatively new concept as compared to Logistics;
- Logistics is only an activity of Supply Chain Management.

2 NEW TRENDS IN SUPPLY CHAINS AND LOGISTICS

The economy of Europe in 21st century faces significant challenges. The ever-decreasing raw material supply, the rising material and energy prices and the demographic changes necessitate the modification of the logistics and supply chains towards more sustainable future. The intensifying competition, which is mostly driven by the increasing productivity of the Asian industry and innovation makes it clear that the production industry needs solutions with which they can efficiently respond (Kagermann 2013) to rising business, environmental and social challenges.

Logistics processes have been gradually complemented with information technology (IT) support tools in recent decades, as increasingly complex technological solutions, production in often multiple locations and the coordination of supporting logistics processes such as demand management started to pose a more and more complex challenge due to large amounts of data that needs to be considered e.g. in case of environmental assessment of complete supply chains. Accordingly, 90% of all production processes are now supported by IT tools. The increasingly dominant role of IT in companies have changed lifestyles and working environments and its significance is unquestionable. IT also affects customers perspective on demanding new products and services. More powerful and well-informed customers are becoming more aware of the global competition, demand more and more personalized products with shorter life cycle. New low cost distribution channels are becoming more and more popular since supply and prices are becoming more transparent. All of these should be achieved with consideration of environmentally sound business solutions.

Forecasting future can be very complex since it is very hard to say what will become an important trend with global impacts and what will only be a »fashion fad«. However One of crucial future trends that will have significant impact on demand management is Industry 4.0. also called 4th industrial revolution. Miniaturization and the development of communication technologies enables the blending of the physical and virtual world and gives way to the so-called CPS – Cyber-Physical System. Industrial production becomes integrated into an intelligent environment that is referred to in reference literature as smart factory (Kagermann 2013). Internet of things and Industry 4.0 will also enable the rise of highly adaptable and flexible start-ups that do not have almost any assets. In time of more and more uncertain demand not having large amounts of assets causing fix costs will become even more important competitive advantage. Because industry 4.0 will enable connectivity and data, environmental

improvements will be easier to achieve and concept of circularity will become more realistic in such systems.

Here the most visible future mega- and micro- trends impacting logistics and supply chain management according to DHL Logistics Trend Radar (2016) are presented:

- First is autonomous logistics with autonomous vehicles and drones. This topic has undoubtfully got the most media attention. Autonomous vehicles are already developed and ready to use in closed loops such as warehouses, airports etc. Next step is to test them on public roads. Drones have already been identified as appropriate for delivery of goods by Amazon (Amazon Prime), for delivering medicines in distant locations, for visualization and monitoring of degraded or by natural disasters affected areas as well as for monitoring radiation e.g. in Fukushima. This trend will significantly change car manufacturing industry as well as understanding personal mobility in general. Huge industry will have to adapt to new, establishing demand. Optimizing fuel economy and selected routes as well as minimizing traffic congestion will also enable severe environmental improvements and decrease energy use for transportation.
- Second innovation is Internet of things (IoT) and its potential of connecting, monitoring and managing electronic devices connected with internet. It is evaluated that over 50 billion devices will be connected by 2020 and this will result in 1.9 trillion dollar worth new business opportunities. Due to safety regulations and related risks, IoT has currently more interest on for households and their appliances but will be implemented also in logistics sector. IoT will also enable better and more focused customer communication and will make the market even more transparent. From environmental perspective, IoT will enable data required for the optimization of operation of machines and will enable higher utilization which leads to lower demand for new machines and consequently also decreased material use.
- Third chance is represented in collaboration of humans and machines. Machines will join human work force. Studies revealed that smart glasses technology increases efficiency for 25 % and are positively accepted by users. This can also be expected in robotics and automation, which is still very interesting for logistics sector with new robots will be cheaper, smaller, more flexible and easier to program. Increasing demand for vacuum cleaner robots or lawn mower robots already reflect this trend also in households.
- Fourth chance is related with retail logistics. We can expect deliveries of anything, at anytime, anywhere to anyone. Customers are more and more informed and use different “online” and “offline” channels. Logistics must adapt to this trends with multichannel and

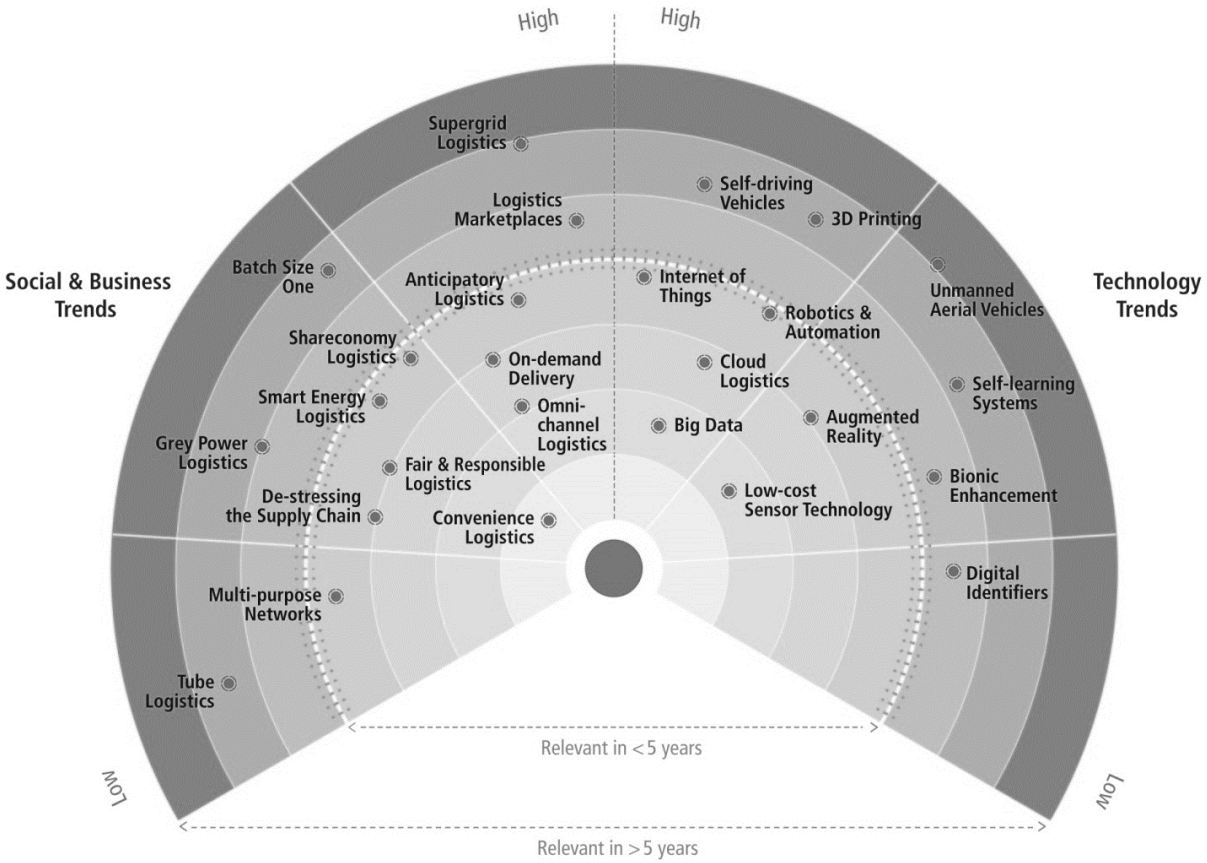
personalized solutions. Trend dictates elimination of cost intensive last mile logistics, related with high costs towards automatization (in Slovenia there are GLS and Pošta Slovenije post boxes on gas stations) as well as delivery in trunks or last mile delivery with energy efficient drones. Customer participation will also play a significant role demanding products and services and new sustainable transportation solutions will be developed and implemented.

- According to above mentioned trend, it can be seen that the fifth trend is focused on integrating environmental protection in general development paradigm. Stricter legislation, scarce materials and fossil fuel and increasing environmental awareness will force companies to become greener. Customers demand green and socially responsible solutions. Focus is to generate added value with environmental components and to implement circular economy with the goal of zero waste concept. As a case Freitag bags can be presented since they are produced from waste truck tarpaulin or Fairphone cell phones, produced from environmentally undisputable and not scarce materials.

Due to increasing population, scarce materials and environmental pollution, urge to reduce environmental footprint can be identified as one of the most important trend-lines that will significantly change customer demand and consequently supply chain management (GreenPort, 2010). In last decade, the issue of environmental protection and climate change has turned from a niche issue discussed by a closed circle of learned specialists into one of the most serious concerns of our times. The EU has not only been leading international efforts to combat climate change, it has also developed an integrated climate and energy policy, including a number of headline political targets and a detailed action plan on how to achieve them (Winterstein & Tranholm Schwarz, 2008). This will also directly affect the demand management with reduction of scarce and hazardous materials allowed to be used on production sites and greater focus on local raw materials. In energy intensive companies demand managers will need to get energy management skills to be able to achieve the best price for dispersed and volatile energy, produced from renewables. Choosing suppliers with environmental certificates, environmental standards and labels will become a mainstream in demand management. This can already be seen in case of printing houses, demanding Forest Stewardship Council (FSC) Certificate or in companies with implemented ISO 14001 Standard which requires that their suppliers also need to have environmental management or in construction industry where Environmental Product Declarations (EPD) are becoming more and more important.

Social and business as well as technology trends related to logistics sector are presented on Figure 7 as well as their relevance through time. However, there are also trends that bring some additional risks to companies dealing with supply chain management. The riskiest areas identified are a) data security and b) vulnerability of IT used for demand forecasts in case of frauds and cyber-attacks. According to demographical changes (older population) and stressful environment, grey power logistics and de-stressing of supply chains as well as shared economy will gain more power. E.g. AirBNB platform offering shared use of unoccupied flats, houses and apartments etc. has already become the largest provider of leisure and business accommodation on the world. Fair and responsible logistics will become important in the next 5 years as well as anticipatory logistics with the goal to minimize costs and to increase customer loyalty. Batch size will be reduced due to more personalized solutions. On the side of technology trends there are numerous trends that will affect previously described Industry 4.0 such as augmented reality, sensors, cloud logistics, bionics, self-learning systems, 3D printing and especially IoT as well as self driving unmanned vehicles. All of these seems to be very distant at the moment, but supply chain managers must be aware of fast changing business environment and especially changing customer demands which they have to forecast correctly and apply appropriate business models and actions to survive and to gain the greatest benefits.

Figure 7: Social and business and Technology trends impacting logistics and supply chains



Source: DHL, 2016

3 GREENING THE SUPPLY CHAINS

The supply chain encompasses all activities involved in the transformation of goods from the raw material stage to the final stage, when the good and services reach the end customer. Supply chain management involves planning, design and control of flow of material, information and finance along the supply chain to deliver superior value to the end customer in an effective and efficient manner. All activities within supply chain cause environmental impacts. Transformation of raw materials into finished products uses raw materials, land, energy, water and causes pollution to air, water and land. Transportation uses mainly fossil fuels that cause harmful green-house gas emissions when burned. Distribution centres and warehouses sometimes use lots of energy to cool the products stored. Almost all goods are packed and this causes use of virgin and secondary material for production of packaging. At the end of the supply chain wastes are created. To reuse or recycle waste energy and some raw materials are needed for this transformation and harmful emissions can be released.

Therefore, if a company wants to assess and minimize its environmental impacts, the whole supply chain including manufacturers, suppliers, distributors, transporters, warehouses as well as customers and reverse logistics must be considered and studied comprehensively.

Green Supply Chain Management(GSCM), is an emerging area in supply chain practice, which integrates environmental management with traditional supply chain management (Burrit et al. 2011) The definition and scope of GSCM in the literature has ranged from green purchasing, material sourcing, to integrated green supply chains flowing from supplier to manufacturer to customer, and even reverse logistics but it tipically combines all above mentioned activities with a goal to make supply chains more environmentally sound (Kumar and Chandrakar, 2012; Burritt et al. 2011; Sajjad, 2015).

Greening the supply chain and incorporating sustainability into business strategy is becoming a highly topical issue for many enterprises and a challenge for logistics management in the 21st century. The waste and emissions caused by the supply chain have become one of the main sources of serious environmental problems including global warming and acid rains. Energy use, fossil fuels extraction and unsustainable material use and consumption also drives us towards exhaustion of the world. Greening supply chains therefore aims to equalize marketing performance with environmental issues (Kumar and Chandrakar, 2012) (e.g. reduced material

costs because of dematerialization strategy and use of secondary or recycled material) (reduced land use, energy use, emissions etc. due to more efficient material use).

Green Supply Chain Management covers Green Design, Green Manufacturing, Green Logistics and Green Marketing too. Distribution that is an important part of supply chain plays an important role in the success of marketing efforts. If a green product has been manufactured in an environmentally responsible manner, then it needs an efficient distribution mechanism for the product to reach out to the customer. The purpose of green supply chain management according to Ganapaty (2014) is as follows:

- Reducing waste and environmental pollution.
- Choosing and using environmentally friendly materials
- Integrating environmental goals and policies into business strategy
- Use less resources (energy etc.) and control and minimize emission.(Ganapaty, 2014, p.8-11).

When a company manages its wastes efficiently, it stands for that its resource productivity is high and the business is able to manage cost efficiencies well. On one hand, environmental concerns including climate change, energy use, environmental pollution and resource depletion are not problems that can simply be wished away. One of the key aspects to green supply chains is to improve both economic and environmental performance simultaneously throughout the chains by establishing long-term buyer–supplier relationships. (Kumar&Chandrakar, 2012; Burritt et al., 2011)

Implementing, GSCM is both an opportunity and a challenge. There are tangible and intangible benefits of moving towards a Green Supply Chain such as.

- Increased legal compliance –legal aspect of sustainable and green SCM
- Increased revenues
- Satisfaction of moral and social obligations
- Improved brand recognition and reputation.
- Better relationships with stakeholders (suppliers, customers and employees)
- Long-term sustainability of firm
- Community development

The Framework for establishing Green Supply Chain Management is additionally presented on Figure 8. It can be seen that GSCM is a combination of different measures, containing green logistics, green supply chains, green innovation, green certification, green production and recycling. That means that it must consider environmental improvements in all parts of the supply chain, from product design, material sourcing, production, distribution, use and end of life phase.

Figure 8: The Framework for Green Supply Chain Management

Source: Green Supply Chain Management, n.d.

Kyoto Protocol pioneered the concept of mandatory reduction and compliance of emission reduction norms for major polluting economies in the world by 2012 and beyond. This prompted the corporate world to go in for introduction and commercialisation of cleaner green technologies to mass produce and market wide-ranging green products. Consequently the concept of Green Marketing also developed. The concept GSCM has been a parallel development to push the green products in an ever-expanding market with huge future potential - given growing customer consciousness towards eco-friendly green products and changing lifestyles (Sarkar 2012a) and to include environmental thinking in conventional SCM.

Nowadays in most of the leading green SC's the concept of life cycle thinking can also be detected. However, the main focus is still on efficient resource use and reduction of waste (Denac et al. 2018). GSCM promotes product's and process' innovations in the area of stronger customer relations also in case of communication with customers about activities, standards

and measures related with greening the SC's to impact the green consumers purchasing decisions (Sarkar 2012a; Sarkar 2012b).

Main goal of GSCM is integration of environmental issues in SC strategy and taking care of the environment also beyond the boundaries of single organization and can be seen as a competitive advantage. Consequently environmental labels dealing with the whole SC perspective are also a part of GSCM. GSCM also reduces risk of environmental accidents and pollution, increases flexibility in supply chains, promotes continuous improvements within SC and is focused on cooperation of all SC members and coordinates suppliers' and customers' activities related with GSCM, designing green distribution, cleaner production and reverse logistics.

Differences between conventional and green SCM are presented on Table 2.

Table 2: Differences between conventional SCM and green SCM

	Factor	Conventional SCM	Green SCM
1	Orientation	Economic	Ecological + Economic
2	Focus of optimisation	Integrated approach	High ecological impacts
3	Supplier selection	Price (short term relations)	Ecological aspects (long term relations)
4	Short term costs	Low	High
5	Long term costs	Higher	Lower
6	Risks	Higher	Lower
7	Environmental knowledge	Low	High

Source: Sarkar 2012a; Ho et al. 2009; Bratina et al. 2017

SC managers are many times convinced that greening the SC is related with higher costs. This is not necessary true anymore (Denac et al. 2018) and can often result in additional economic benefits as well. Environmental management schemes such as ISO 14001 certification is becoming the industry standard in determining marketing channel partners in the risk of losing customers and increasing costs. Therefore adapting to stricter forthcoming environmental

legislation, increasing customers' environmental awareness and share of green oriented consumers as well as requirements of business partners can only bring benefits on a long run.

Nones et al. (2004) and Sarkar (2012a) believe that introducing green SC must be based on four steps:

- Evaluating costs of transition into GSCM;
- Identify and set possibilities;
- Calculate potential benefits;
- Take decision on acting in green direction and start with changes

However, organisation must always consider its organizational structure, needs and corporate culture since every organization is unique and specific therefore completely unique and versatile solution do not exist. Nonetheless Elkingtov et al. (1993) set some basic and generally applicable directions on characteristics that green SC or green product can not have such as:

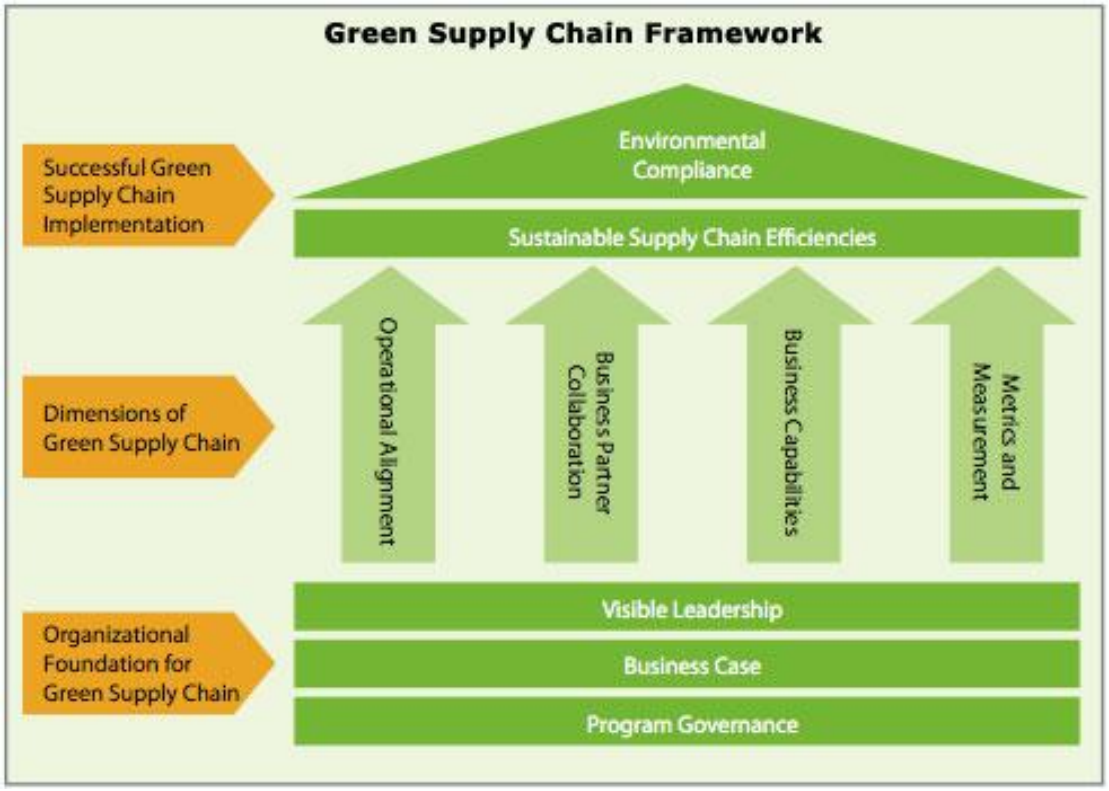
- It should not endanger human (or animal) health;
- It should not harm the environment in any phase of its life cycle;
- Energy and resource use should not be inconsistent between different life cycle stages;
- It should not cause unnecessary wastes regarding additional or inappropriate packaging, inability of maintenance, etc.;
- It should not include the use or torturing of animals;
- It should not be related with materials or substances related with endangered species or restricted and environmentally protected areas;
- It should not cost the Earth.

General framework of green SCM is presented on Figure 9. When thinking on starting with GSCM organizations must be focused on:

- Target marketing;
- Sustainable resources;
- Reducing costs and increasing efficiency;
- Dividing products from competitive advantage;
- Adapting to legislation and reducing (current or forthcoming) environmental risks;
- (Green) branding;

- Return of investment;
- Increasing environmental awareness within the organization and
- Decreasing pressure of competitors due to market differentiation.

Figure 9: Green Supply Chain Framework



Source: **(Diamond Management and Technology Consultant, n.d.)**

Companies must be aware that achieving environmentally sound SC is not an easy task and requires comprehensive structural changes within the whole SC. Focus must be set on new processes, deepened cooperation between SC partners, new business models and sometimes also cooperation with competitors.

When talking about "Green SC", the existing literature shows concerns regarding environmental and economic performance of a supply chain. Next level is "Sustainable SC" that is a concept that incorporates also the social dimension and is sometimes used as a synonym for green SC.

CASE STUDY 2 - Making SC more sustainable is not an easy task

Management of Chinese company Esquel, one of the global leaders in textile industry, identified new business challenge in requests of its main customers such as Nike and Marks&Spencer that became more aware on what is the world biggest shirt producer doing for environmental protection and how socially responsible it is. Esquel expected that their other buyers could start to ask the same question in the near future, therefore they decided to make a transition to and make their SC more sustainable. The key issue was increasing the amount of organic cotton but the biggest challenge was that none of their customers were ready to pay much extra for organic cotton. Esquel became aware that the challenge is far more complicated that first predicted. They could not just request from their suppliers – farmers, mostly located in north-western China, to use less water, renovate their watering systems, use less and fewer fertilizers and pesticides as well as toxic chemicals etc. because this could have catastrophic consequences for farmers because of decreased yield for 50 % in case of organic farming and consequently decrease of their income. Producing organic cotton requires less chemicals but its further processing require more of it due to weaker fibres and different physical properties of organic cotton. Paradox is well known and companies' changed business model and activities carried out to achieve more environmentally sound SC can trigger a whole series of unpredictable consequences that at least partly eliminate the environmental benefits for which they strive.

Esquel therefore tried to achieve balance between sustainable oriented development, improving social corporate responsibility and or course achieving good financial results. They started with comprehensive structural changes of its SC focused on new processes and different type of cooperation between SC partners. They helped farmers with renovating water systems, educating them about the benefits of organic farming, natural ways of pest control etc. In addition, Esquel introduced other methods of harvesting cotton. Previously, farmers used chemicals so that harvesting machines carried out their work easier. Instead, farmers started to pick cotton manually to avoid excessive use of hazardous chemicals. This is on the one hand more expensive and slower, but on the other hand the cotton that is being processed is much cleaner and the subsequent phases of cleaning (where additional chemicals were used) are no longer needed. There is also significantly less waste. They also developed ecological colours for colouring their products. Crucial change was also that farmers were not just suppliers any

more but became partners with guaranteed long term quantity and purchasing prices for organic cotton that were app. 30 % higher than for regular cotton. This also enabled farmers to make a transition to organic farming and actually achieve higher standard of living simultaneously and in accordance with product's added value.

4 INTEGRATING LIFE CYCLE THINKING IN SUPPLY CHAIN MANAGEMENT

4.1 Why is Life cycle thinking important for supply chain managers?

Organisations are becoming more and more aware of their environmental impacts and are taking measures on minimizing their impacts with integration of cleaner production within the organisation, increase energy efficiency and decrease the energy use of final consumers, optimize transportation and distribution or dematerialize production in order to reduce costs. Due to increasing energy scarcity seen especially in the EU, Cerovac et al. (2014) noted that not just the amount of energy used in production, an important factor is also to consider the mix of energy sources used within the SC. However all of these measures are partial measures that do not concisely cover all environmental impacts related with company's SC. Increasing material prices related with material depletion, stricter environmental legislation especially in the EU and increasing customers' environmental awareness force companies to take comprehensive measures.

When talking about sustainable or green SC, SC managers should consider all phases of products life cycle that do not cover only individual SC members but the whole SC. When considering only production, logistics or use of certain product only partial environmental burdens can be identified and such analyses can be misleading and might not address the most important environmental impacts and consequently most appropriate environmental improvements can not be implemented. This idea is the basic principle of Life cycle thinking, meaning that environmental impacts in all phases of the life cycle must be considered, including raw material supply, production, distribution, use and end-of-life phase (in SCM frequently related with reverse logistics). The focus is to include comprehensive environmental burdens and to address them in accordance with their importance within the whole SC. The tricky part is that life cycle thinking requires cooperation of all parts/members of the SC and can be problematic especially for small and medium sized enterprises that do not have sufficient negotiating power in relation with larger and stronger suppliers. Nonetheless it must be clear that sustainable production and consumption can be achieved by bottom-up (from employees to managers) and a top-down (from managers to all employees) approaches or by implementing new business models (Lukman Kovačič et al. 2017) meaning that this is not just a task of the top management but a commitment of a whole organization.

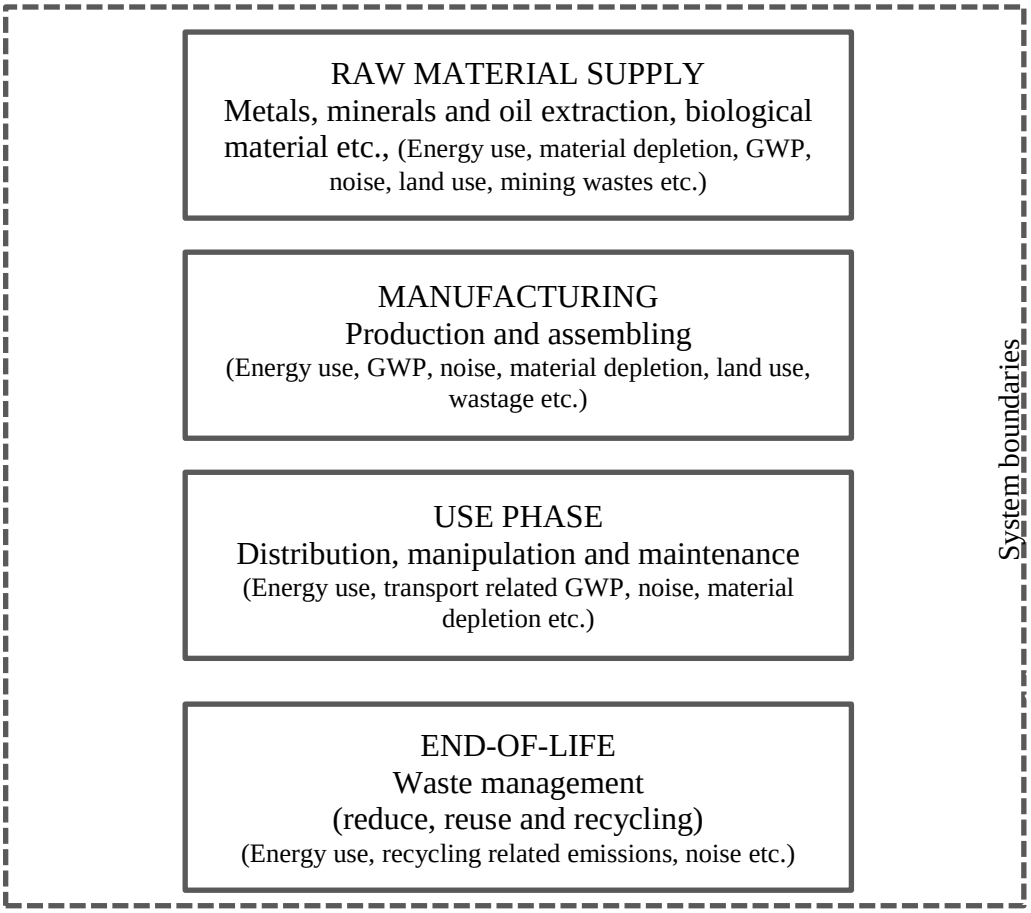
4.2 Life cycle phases

To design environmentally friendly products or services, their environmental impact must first be assessed within the whole life cycle. Life cycle assessment (LCA) has frequently been identified as an appropriate method for the comprehensive assessment of the environmental impacts of a certain product, because it evaluates environmental impacts through all phases of the life cycle, and it gives good overview of a numerous environmental impacts that are not immediately apparent. However, due to the high amount of data needed and included in LCA, it is an extremely complex and time intensive method for evaluating environmental impacts (Obrecht and Knez 2017).

Life cycle stages, impact categories, and system boundaries required in LCA are presented in Figure 10. Figure 10 presents the phases of products life cycle and the system boundaries of LCA, focusing on all main life cycle phases. Only after identifying and assessing environmental impacts through the whole life cycle, companies can see which impacts in their supply chain are the most critical and can therefore start to work on environmental improvements or even on avoiding them at all. Usually (but not necessary), the most common solution is to start optimising phases with the greatest environmental impact and those that seems to have the greatest opportunities for reducing their impacts.

LCA is currently the only standardized method (within the ISO 14000 series) to assess environmental impacts through the whole life cycle however; LCA itself is only the first step towards more environmentally sound SC since it only reveals environmental impacts but does not actually minimise them. The next step is e.g. the use of ecodesign tools, which enable the minimisation of environmental impacts identified with LCA (Obrecht 2010). The main point of life cycle perspective for the most of manufacturers is that their obligations expanded and their (environmental as well as legal) liability does not end at the factory doors.

Figure 10: Life cycle phases and system boundaries of LCA



Source: Obrecht and Knez, 2016

CASE STUDY 3 – IBM's and Apple's efforts to start with the life cycle thinking

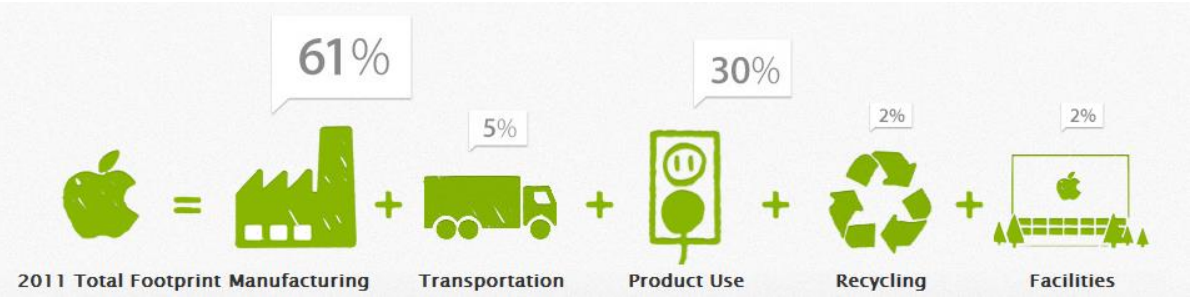
IBM is an example of a company that pushes the envelope even more. IBM proposed initiative based on the Electronics Industry Code of Conduct - EICC to mandate their marketing channel partners to adopt environmental measures meaning that they were not focused just on their own organization but tried to push the whole supply chain with all phases of their products live cycle stages to make some improvement and to become also transparent and presented their environmental impacts to the public stakeholders. They proposed four things requested to be realized by their suppliers:

- Define and deploy an environmental management systems (EMS);
- Measure existing environmental impacts and establish goals to improve performance;
- Publicly disclose their metrics and also their results;
- "Cascade" these requirements to any suppliers that are material supplier to their (IBM's) products.

This culminates to the costly venture of life cycle analyses of their products and tracking the footprint of every step of a product and by measuring as well as being able to measurably improve environmental impact. Top managers are becoming aware that the environmentally sound path of business development is becoming more and more profitable. Consequently organizations are becoming more interested in lean, smart and green supply chains focused also on identifying and decreasing environmental burdens in their whole SC with life cycle thinking.

Apple has already done this and reported on their results in a consumer friendly and simple way as presented on a Figure 11.

Figure 11: Apple's communication with stakeholders about its environmental impacts with included life cycle perspective chain / life cycle



Source: Apple 2012

5 ECODESIGN INTEGRATION

5.1 Ecodesign principles and ideas

Even though main environmental impacts are caused within material extraction, production, use of even after the end-of-life, most of the environmental burdens of a product are determined already at the design phase. Therefore this phase represents a key step when improving a product's environmental performance (Obrecht and Knez 2016 and Prendeville and Bocken 2017). When talking about sustainable supply chains all phases of products life cycle must be considered and if possible optimized already when designing the supply chain. If environmental considerations are taken into account preventively during the earliest phases of product or supply chain development, then it is more likely that the product's overall environmental impact through the whole supply chain can be significantly decreased. One such tool that enables preventive approach is also eco-design.

The ecodesign is based on the integration of environmental aspects into product design and development, with the aim of reducing adverse environmental impacts throughout a product's life cycle (Denac et al. 2018). Literature review revealed that ecodesign is based on cleaner production, sustainable development and life cycle perspective. The central aims of ecodesign are to reduce the consumption of (especially scarce and primary) resources, use more renewables, use fewer hazardous materials, increase the use of recycled materials, optimize production and distribution, make production cleaner, prolong the lifespan of the product, and make end-of-life management easier and more efficient both environmentally and economically (Brezet and van Hemel 1997). This means that the potential of the economic and environmental advantages of ecodesign goes beyond the reach of the manufacturer and connects the design of a product to a wider network of supply chain members including raw materials extraction, production, transport and distribution, use and disposal, with efforts to minimize impacts in all these phases.

However, ecodesign or green product development is not that easy to implement (Albino et al., 2009) since it includes life cycle thinking, sustainable development and cleaner production simultaneously (Brezet and van Hemel 1997). This is especially true for small and medium enterprises (SMEs) (van Hemel and Cramer 2002). Although many ecodesign methods and tools are currently available, there is a gap in their integration into the design process as well as into the daily practice of designers especially if the top management is not committed to

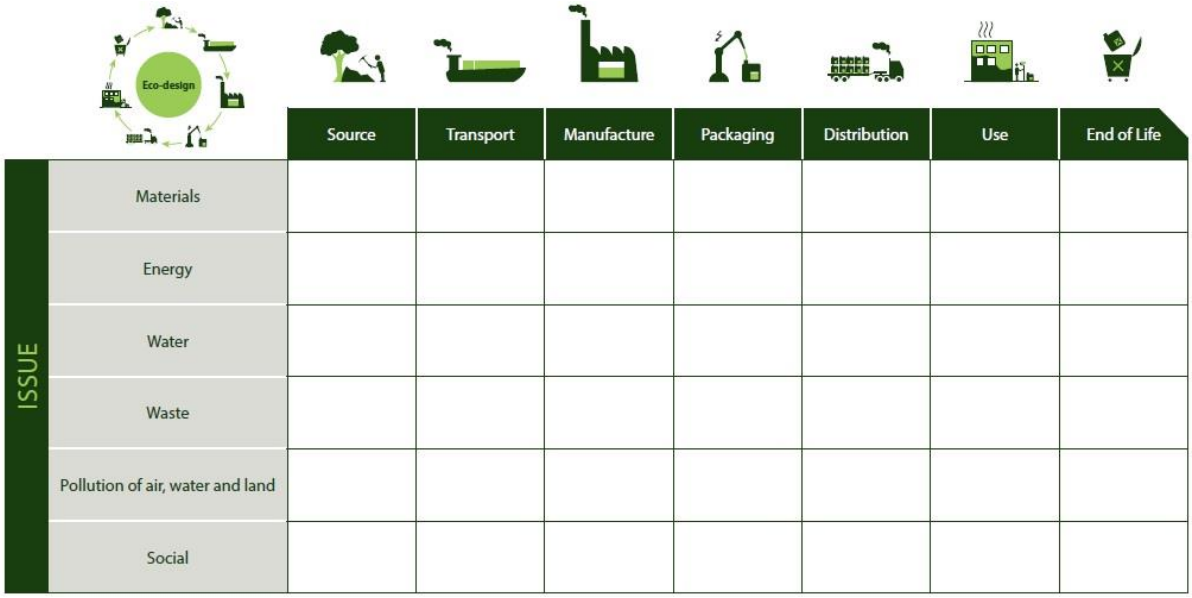
greening the company's supply chain. Existing ecodesign methods are not always suitable for all organizations or business sectors (Andriankaja et al. 2015). Consequently, ecodesign activities must be planned carefully and systematically, especially in SMEs where human and financial capital is often limited (Eco-Innovation Observatory 2016; van Hemel and Cramer 2002). This needs the support and commitment of top management including SCM, regardless of the size of the company (Annunziata et al. 2016; Dekoninck et al. 2016).

5.2 Ecodesign framework and tools

When starting with ecodesign, the first step is to assess environmental impacts and burdens through the whole products or service life cycle. This can be done in different ways such as with LCA or with some simplified measures such as by using the Product Lifecycle Impact Tool (LIT) or even with ecodesign specific questionnaires. LIT can assist companies in understanding the impacts associated with their product or service environmental impacts (MRA and EEN 2013 and Denac 2018).

Some of the issues included in LIT on the Figure 12 may not be relevant to a specific product however the core idea is to force product designers to start to think about environmental impacts caused outside the company's walls. For example very small amount of energy will be consumed by a lavatory (only lighting) in use and the issue of water consumption will not be so significant in the products distribution phase, however supply chain managers must be aware of comprehensive minimisation of environmental impacts and they should consider minimize it when designing green SC. LIT therefore allow companies to eliminate some impacts and maybe also lifecycle stages (parts of the SC) and highlight areas where the major impacts arise. The matrix is useful because once it has been completed, products designers as well as (SC) managers can easily see which issues at what lifecycle stage need to be in the focus of eco-design. They can easily identify the hotspots (MRA and EEN 2013 and Obrecht 2010) when they start to consider which impacts to reduce (if not all of them due to limited resources and production capabilities).

Figure 12: Lifecycle impact tool (LIT)



Source: adapted from MRA and EEN 2013 and Obrecht 2010

Having used the LIT to identify the most significant environmental impacts in the product lifecycle product designers and managers (especially technical directors and supply chain managers) will have to consider the potential design improvements which provide the greatest opportunities to reduce these impacts. In Table 3 ecodesign questionnaire is presented with different design focus areas in accordance with ecodesign strategies which are at some extent applicable to all types of products or services. It must also be considered that due to relations within products SC and life cycle activities to improve product's environmental impact, additional costs or benefits can arise to organizations representing other supply chain members therefore comprehensive analysis is crucial to achieve the best result from the supply chain perspective.

Although many ecodesign methods and tools are currently available, there is a gap in their integration into the design process in the industry, as well as in the daily practice of designers. According to Andriankaja et al. (2015), existing ecodesign methods are not always tailored to lightweight structures. Gerrard and Kandlikar (2007) foresee that the most substantial change in the design within the transport sectors is the design of new products, involving a change in the material composition: promoting the use of lightweight materials, extending the value of end-of-life (reuse and remanufacturing) and improving the environmental communication about products. Simplifications of these methodologies are crucial for a comprehensive impact

assessment and the minimisation of environmental impacts because their outputs are easier to obtain and cheaper for the producers to carry out.

Table 3: Ecodesign Questionnaire

Design Focus Areas	Key Questions for Designers	Environmental Benefits	Business Benefits
Design for Material Sourcing	When you specify materials and components, do you consider the impact on the environment related to weight, volume, use of recyclates, embedded energy and water and impacts on biodiversity?	Reduced resource depletion Reduced embodied energy/water Reduced transport burden Reduced carbon dioxide (CO2) emissions Reduced impact on biodiversity	Reduced transport costs Improved Image/access to markets
Design for Manufacture	Have you considered changing manufacturing processes to reduce energy and water use, waste and recycling of waste?	Reduced CO_2 emissions and depletion of water resources Reduced resource depletion	Reduced energy costs Less waste - Reduced material cost
Design for Transport and Distribution	Have you considered size, shape and volume of your products from a packaging and transport viewpoint? When specifying packaging do you consider embodied energy and water, production of VOCs or hazardous substances?	Reduced CO_2 emissions and depletion of water resources Reduced air pollution Reduced transport use – less emission and wear and tear on infrastructure Reduced potential for proliferation of hazardous substances in the Environment	Reduced transport costs Reduced packaging costs
Design for Use (Including installation and maintenance)	When you design your products, do you think about their energy and/or water consumption when they are used? Do you consider the amount of consumables and any hazardous materials that may be released during use? Do you consider their longevity and ease of maintenance?	Reduced demand on new material resources Reduced CO_2 emissions Reduced depletion of water resources Reduced potential for proliferation of hazardous substances in the Environment	Lower lifecycle costs for customer – increased profits from increased prices Reduced maintenance costs Good product image
Design for End of Life	When you design your products, do you think about how easily they could be reused or dismantled and recycled? Do you consider any hazardous substances in the product that might be released during dismantling or recycling?	Reduced use of land for landfill Reduced demand on new material resources Reduced CO_2 emissions Reduced depletion of water resources	Compliance with regulation Reduced end of life costs

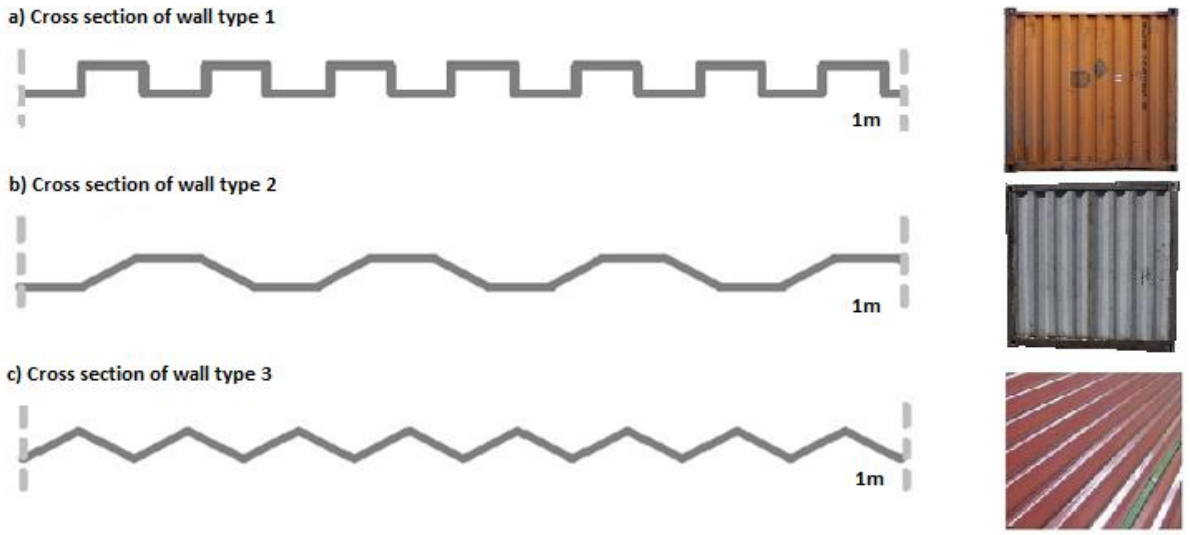
Source: adapted from MRA and EEN 2013 and Obrecht 2010

CASE STUDY 4 – Simplified eco-design approach for carbon and resource savings in different cargo container designs

(adopted from the study of Obrecht and Knez 2017)

Currently, a huge amount of cargo containers is transported with maritime and road transport throughout the world which results in high environmental impacts caused by the transport as well as by the manufacturing of the containers such as material depletion due to the large quantities of material used for the production of approximately 18.6 million cargo containers globally in use. Another environmental impact is carbon emissions released in the production and use of cargo containers. One possible solution for more sustainable cargo transport is to design environmentally friendlier cargo containers, made according to ecodesign principles. They are lighter, produced from less material with smaller environmental impact throughout the life cycle. Our previous study focused on standard ISO 20-foot cargo container designs with a simplified life cycle assessment study focusing especially on green-house gas emissions revealed that environmental impact of a cargo container is the highest in the first phase of its life cycle, i.e. raw materials.

Figure 13: Cross sections and pictures of three examined container Wall Types

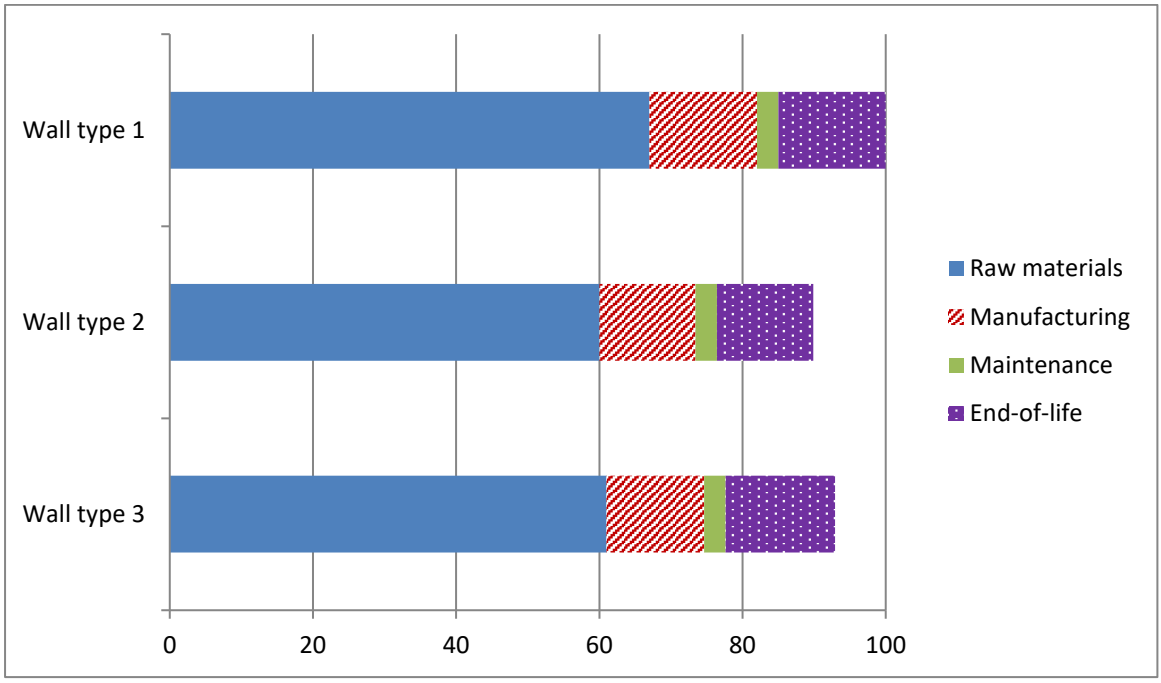


Due to the relatively high mass of standard 20-foot aluminium and steel cargo containers (1,877 kg and 2,250 kg respectively), and nature of the materials manufacturing phase (raw material processing, welding, assembling, etc.) this accounts for 67 % of all impacts. A solution for environmentally friendlier cargo containers is seen in an ecodesign dematerialisation strategy with particular emphasis on the use of material and production phase but without compromising

its performance. Three different designs of cargo container walls presented on Figure 13 were assessed from an environmental perspective.

Comparative analysis has shown a difference of approximately 15 % (315 kg of primary material per single container) in material use when comparing cargo container wall type with the highest and the lowest impacts and significant differences also within environmental assessment as seen on Figure 14.

Figure 14: Comparison of relative GWP of different studied container Wall Types



Possible reductions of material used for cargo containers means that 20.97 square meters of aluminium or steel is used just for one side wall of a standard 20-foot container and of course twice as much for a standard 40-foot ISO container when using the Wall Type 1 design. A significant reduction can be achieved when replacing Wall Type 1 containers with Wall Type 2 or Wall Type 3 containers. The amount of material used for one side wall of a standard 20-foot container can be reduced with the implementation of Wall Type 2 or Wall Type 3 design by 6.13 m^2 and 4.86 m^2, respectively.

Additional environmental improvement and cost reduction can be seen on mega container ships that can load more than 18,000 twenty-foot equivalent units (TEU). That means that loaded mass can be reduced by 4,734 tons when comparing aluminium containers and for 5,670 tons when comparing steel containers just by adapting container designs, *ceteris paribus*.

Significant improvements can consequently be expected also in container ship fuel economy. Due to the large amount of cargo containers throughout the world and container ships on the sea, the change of Wall Types could bring a massive impact to the reduction of material use and fuel economy as well as on maritime greenhouse gas emissions.

The term "environmentally sound design" refers to the measures taken to develop the products as environmentally friendly as possible. This way it reduces the environmental impact of products in the whole product's lifetime without compromising other product features, such as functionality, price, and quality (Johansson 2002). Sustainable product design, also used in some cases instead of ecodesign is the philosophy and practice of design in which products contribute social and economic prosperity and have a negligible impact on the environment and can be produced from a sustainable resource base (Niinimäki 2006; Lewis 2012).

Companies that are taking actions related with environmental protection within the whole SC such as designing their products to be environmentally friendlier usually tend to gain financial benefit out of such activities that can be in the first phase quite cost intensive. Therefore environmental improvements and efforts should be awarded with different awards as well as with labels informing potential consumers about products environmental impact to promote sustainable production and consumption. In the next part focus will be on environmental labels and certificates.

6 ENVIRONMENTAL LABELS

6.1 Defining and dividing environmental labels

In the flood of products on the shelves of shops average consumers can get confused when thinking on environmental performance of a certain product or service. When environmental awareness is on a rise and the share of green consumers is increasing, many companies and consumer organizations identified the need to introduce product's declarations on products environmental performance to enable potential consumers to get more information on environmental impacts of a certain product. It is actually almost impossible for consumers to evaluate themselves which products are environmentally more and which are less disputable (which cause more and which less environmental burdens). With the current focus being mostly directed at environmental changes of climate and health, the demands of customers for greener and environmentally friendlier products is rapidly increasing. This forces manufacturers to start thinking out of the box and start to show the customers that their products fit their demands (Korent et al. 2018). Therefore environmental labels or tags were developed based on the principle of better known labels related with product quality or origin. Environmental labels are labels that help consumers to quickly identify environmentally friendlier products and services and can be related on environmental impacts, energy use, water use, hazardous materials or other environmentally related criteria (Obrecht et al. 2017).

Environmental labels can be divided in different subgroups. The simplest division is on mandatory and voluntary environmental labels (Horne 2009). Mandatory labels are usually prescribed by law and are most commonly related with energy and water use. On the other hand voluntary labels can be divided on different ways. Here labels are divided according to ISO classification that divides them into three groups (ISO 14024:2018; ISO 14025:2006; Obrecht et al. 2017, Bratina et al. 2017):

- **ISO type I** (environmental labels type one based on ISO 14024 standard) – includes most important and well known labels granted and monitored/revised by independent organizations (e.g. EU Ecolabel);
- **ISO type II** (environmental labels type two based on ISO 14021 standard) – more for informational purposes, voluntary declarations, used by producers, distributors, retailers etc.. These are labels without independent monitoring and have the lowest scale of

credibility. However due to marketing purposes and relatively easy acquisition they are very common;

- **ISO type III** (environmental labels type three based on ISO 14025 standard) – informs potential consumers about impacts of certain product on environment and includes also life cycle perspective. It is most commonly used for construction materials – e.g. Environmental product declaration (EPD).

Organizations noted the need for labelling their products with environmental information due to rising environmental awareness of customers, stricter environmental legislation and potential differentiation of their products. Environmental improvements can additionally increase products added value.

Even though many environmental labels exist nowadays, companies are still poorly aware of the wide choice of even mandatory but especially voluntary environmental labels and tags (Obrecht et al. 2017). Even organizations that are aware of them lack the knowledge on their pros and cons as well as on their requirements related with companies supply chains. Even though they are based on different standards, different legal requirements and they might be focused on different environmental areas or focus on different parts of the life cycle that require differently intensive activities for their incorporation, all of them are somehow related with environmental information important for potential users or buyers (Yenipazarli 2015).

Environmental labels can be seen as an information tool to help (especially green oriented) consumers to choose environmentally better products that fulfil high standards of maintaining and preserving users health and/or environmental sustainability. From the perspective of comprehensive environmental knowledge the most important are labels that incorporate environmental burdens related with the whole life cycle of a certain product from cradle to grave and can significantly increase product's added value (Chakravarthy et al. 2016) within its whole SC.

Companies that taking care of the environment and tend to contribute to a more sustainable future are most of the times interested in achieving economic benefits simultaneously with environmental ones. Improving company’s image, differentiation strategy, niche products or improved communication with green consumers can be such activities that enable business benefits. Especially for communication with potential customers environmental labels are identified as an appropriate and potent tool. In this part the most common, innovative and comprehensive environmental labels that consider life cycle perspective are examined as well

as their impact on SCM. Information flows enabling the certification of different ecolabels is also discussed.

In the next section the EU Ecolabel, Cradle to Cradle certificate and Environmental Product Declaration (EPD) as the most prosperous environmental labels with included life cycle perspective are examined. Their logos are presented on Figure 15.

Figure 15: Logos of Ecolabel, C2C and EPD certificates

a) Ecolabel logo b) Cradle to Cradle logo c) Environmental Product Declaration logo

Source: European Commission 2018a; Cradle to Cradle Products Innovation Institute 2018 ; EPD International 2018

6.2 Ecolabel

An EU Ecolabel is a label or mark that can be found on everyday products such as detergent, paint and paper products, and indicates that an independent third party has evaluated the product against multiple environmental criteria to make sure that it passes the most stringent health and environmental tests. EU Ecolabel products are supposed to be “best-in-class” and are held to the strictest environmental standards that exist (European Commission 2018a).

As an ancestor of the EU Ecolabel Blue angel can be determined which set the framework of assessing product’s environmental performance with life cycle perspective taken into account. Blue Angel which originates from Germany is well recognized and is one of the pioneers of ecolabel industry (est. 1978). Within Blue Angel product types are separated in four main categories: protection of environment and health, climate, resources or water.

Being part of the European Union, companies became interested into a label, similar to Blue Angel but recognized and accepted on the level of the EU and not just focused on the German

market. This was the beginning of the EU Ecolabel, also called a "Flower" launched in 1992 by the European Commission (European Commission 2018a) and first one awarded in 1996. As of March 2018, 2091 EU Ecolabels were awarded to 70,099 products and services available on the EU market with Spain as a leading country with app. 30,000 of them (European Commission 2018b). In order to get endorsement from independent professionals of EU Ecolabel organization, it is necessary to prove that products or services have reduced their impact on the environment and that they are "green" through their entire life cycle or SC. EU Ecolabel is identified as a perfect environmental label when company's target markets are the EU Member States because it is well known among the consumers across the EU (Bratina et al. 2017) and is also certified as an standardized ISO type 1 environmental label.

The advantage of Ecolabel "flower" from the B2C (business-to-customer) perspective is recognition and popularity among consumers all over the EU. From the B2B (business-to-business) perspective, the pressure on suppliers to cooperate with manufacturer that have this label is very important. It requests that improvements are done and documented through the whole SC therefore even 2nd or 3rd tier suppliers must take some environmental protection activities. The standards for implementing the Ecolabel are designed in the way that only 10 to 20 percent of products on the market correspond to the criteria to acquire the label (Obrecht et al. 2018). Products that have it give clear signal to green consumers that they are considering to buy environmentally top rated products.

Criteria of Ecolabel refer to the important environmental impacts related with products life cycle perspective (Blengini and Shields 2010) and are also in accordance with SC perspective:

- raw materials selection;
- production;
- usage and waste product.

The EU Ecolabel could be awarded for a wide range of product groups. There are currently twenty-seven different product groups covering a wide range of categories, from cleaning products to cleaning services, from home and garden to clothing and paper products, and from rinse-off cosmetics to tourist accommodation services. However it is not suitable and available for all product types and the EU actually already stopped awarding it for some special product types (e.g. heat pumps). Companies interested in the EU Ecolabel must therefore carefully examine the availability and the procedure for its acquisition since these features can change in time just like the detergent products criteria that were revised in order to guarantee

consumers the best environmental performance. This means that if company would be considered to achieve criteria for gaining EU Ecolabel it is not necessary that their environmental improvements within their SC would allow them to keep it or to get it in one year when criteria could be stricken. The criteria for extension to keep the EU Ecolabel are revised every four years which means that products with the Ecolabel stand for the highest environmental performance which must also be improved (European Commission 2017 and European Commission 2018b).

CASE STUDY 5 – Ecolabel based green public procurement in city of Kolding
(adopted from Herman et al. 2018)

City of Kolding (Denmark) incorporated the EU Ecolabel along with other environmental labels into its green procurement processes. The EU Ecolabel is used directly by the City of Kolding whenever they are tendering for goods or services covered by the Ecolabel. The main focus is to avoid only financial perspective and start to consider environmental perspective as a part of public procurement as well. Whenever a call for tender for a product group where ecolabelled products exist the criteria relating the product are simply copied as either technical specifications and/or as award criteria. They state that the bidders on request must document compliance with the specifications and the criteria they say they can comply to. In the last three years, the EU Ecolabel has been included in tenders for cleaning agents, copy paper, work clothes, laundry services (for the detergent used), printing services (for the paper used) tissue paper, and fleet management (for the lubricants used). For every call of tender, except the one for fleet management, City of Kolding reported that a sufficient number of bids were received (in average between 3 and 7). For several product groups the bidders offered a wide range of ecolabelled products such as for cleaning agents where approximately 45 to 60 % of the products offered has had at least one ecolabel with the winning bidder offering 58 % of ecolabelled products. In terms of costs, there does not appear to be a cost disadvantage in asking for products with ecolabel. If anything, the bidder with the highest environmental score tends to be also the one with the lowest price. That means that products that do not have Ecolabel automatically drop out at such tenders. Because trend of green public procurement is increasing, more producers will be forced to implement ecolabels and adapt to stricter environmental requirements set by their customers if they want to remain in business.

6.3 Cradle to Cradle certificate

Envorinmntal labels can also lead to a confusion when consumers are faced with same products having different labels on it. This can lead to quite a confusion on environmental labels credibility, but in short most of them are quite recognised and as mentioned by ISO 14000 series, can help boost a company's reputation in the world market by a lot. As such they are getting progressively vital for a successful or failed "market penetration". Because of that, more and more companies are in progress of obtaining them, or in the process of implementation into their processes.

One of these eco-labels or in our case more like "eco-certificate", is also the "Cradle to cradle" certificate or in short "C2C". Unlike the other more commonly know eco-labels, this certificate is at the moment much less known, but as such it is not less developed or complicated as the others from the supply chain or life cycle perspective. Even if it is globally less recognizend it focuses on the whole life cycle and has very strict environmental reguirements for awarding it as well as special consideration on end-of-life phase. The C2C concept foresees an own certification (Cradle to Cradle Products Innovation Institute 2018). What makes this certificate more specific or different from others, is the fact that it wants to implement a enclosed life-cycle, meaning that that the product is not entirelly discarded at the end of its lifetime, but is instead again incorporated into anothere product.

To understand the whole meaning and purpose of the certificate, we have to explain firstly the concept or the idea on which the certificate is based on. Cradle to cradle concept was first mentioned in a research report to the European Commission in Brussels in the year 1976, by Walter Stahel and Genevieve Reday-Mulvey. The research "The potential for substituting manpower for energy" presented a vision of an economy in loops or later called circular economy. It was primarily focused on how such economy could have an impact on job creation, economic competitiveness, etc. The research was later published in a book "Jobs for Tomorrow: The potential for substituting manpower for energy", and the factors mentioned in the book, are the three pillars of sustainable development: ecologic, economic and social compability. Stahel then continued with the ideas and wrote a paper "The Product-Life Factor", where he discovered or better yet identified that selling utilization instead of goods is much more profitable and can lead to a better business model of a loop economy; in short selling utilization creates sustainable profits and removes the costs and risks that were connected with waste (Product-Life Institute, n.d.).

The next step was the denial of the newly developed concept “cradle to grave“ that is also in accordance with life cycle thinking. Although the concept was widely recognised and already started to be implemented, one of the main reasons being rather compatible with the existing linear economic model, Stahel refused the idea, because it was still only an upgrade for gravediggers, who wanted to get rich with waste, and the whole concept was more or less just an advanced upgrade which sope oposed that it relies on end-of-pipe solutions. Rather then the concept presented by other experts, he promoted another concept, namely “cradle back to cradle“ which would use durable goods in a loop and as such be much more sustainable. At the same time Braungart (2015) promoted the same concept mostly as a response to the rise of the “cradle to grave“ concept, which was according to him, still relying to much on the end of the pipe solutions. The two pioneers soon started to cowork on the newly established concept (Product-Life Institute, n.d.).

Following the colaboration, they published a manifesto in 2002, called “Cradle to Cradle: Remaking the Way We Make Things“ in which the whole design was desribed in detail. Following this published manifesto, a number of companies decided to implement it although soon criticism fall on both authors, mostly for the lack of granting the certificate to other companies, other then those in the inner circle (Sacks 2009). Following this pressure, they decided to establish a special institute, called “Cradle to Cradle Products Innovation Institute“ with which they enabled for the certificate to be publicly obtainable for every company, that is prepared to implement the certificate and its demands.

One of the most importand inovations related with C2C certificate is that it is free to get and works mostly on a donation system, meaning that the companies donate how much they want rather then being forced to pay for obtaining the certificate as it is practice within other recognasible environemtnal labels. This in a way is also much more appealing to the companies, who want to improve their processes.

The main idea of the certificate itself lies in a continual improvement process that looks at a product in five quality categories (Cradle to Cradle Products Innovation Institute 2018);

- Material health (chemical ingredients of every material in a product),
- Material reutilization (designing products with materials that can safely be returned to nature or industry),

- Renewable energy & carbon management (manufacturing powered mostly by renewable energy),
- Water stewardship (manage clean water),
- Social fairness (design operations to honor all people and natural systems which are affected by the product through is life cycle).

The product which the company certified gets achievement evaluation in each of the previously mentioned categories. This achievements are Basic, Bronze, Silver, Gold and Platinum. Unlike others, the product gets it`s overall scoring based on the lowest achievement level he achieved (ex. if the Product has 4 Gold marks and 1 Silver mark, the overall certification level of the product is Silver). Of course this can be always improved and perfected with continues improvement of the processes connected with the product, as well as guideline for the company, what is needed to be done or which category need`s further improvement for the product to become better.

The C2C paradigm is a new approach to business development and is higly interesting for SC managers as well. This approach is also known as circular economy (CE). CE is diffrent from conventional business models by focusing on the SC economy and the possible business opportunities that arise when broadening the horison from gate-to-gate to cradle-to-cradle. The reason for this new horison is the fact that current and future businesses need to ensure a closed or semi-closed loop in their material cycles due to ever less resource availability. Reverse logistics is first step towards it however still having numerous opportunities for improvements and full implementation of the idea of CE.

Another benefit of the C2C product certification is the identification of substitute materials in the material SC in order to promote elimination of dangerous parts from the scarce or hazardous raw materials used in the production. As a result of their change of horisons businesses are now changing their business models towards models with the entire material loop in their product. This also influences the product's design. In other words, the Cradle to Cradle paradigm teaches us to think in a whole new way and teaches us to design recyclable and adaptive solutions corresponding to new business models related with stricter environmental measures integrated within the whole supply chain (Hansen 2015).

CASE STUDY 6 – Implementig C2C on Shoes

(adapted from Korent et al. 2018)

If we conclude all what was described above in an simple example of a product such as a shoe; Shoes are being made in a factory, where the sole is made from »biodegradable materials«, while the upper parts are made out of »industrially made materials«, with which they compliment the material health category. The factory uses for example off-cuts of ruber soles for the development of new soles with which it drasticaly lowers its waste and also compliments material reutilization category. After the finished production, the shoes are sent to retailers, where the buyer pays for the shoe significantly less then for a comparable shoe. That is because the buyer pays only for the usage of the materials, for the period of time he will be using the shoe with which they compliment the social fairness category. After the shoe is for certain reason unusable, it is returned to the factory, where the soles and upper parts are divided. The soles are then returned into nature, where they biodegrade, while upper parts are again used in factory for creation of new shoes.

Although this is a simplified example, it clearly shows the difference between other concepts, where the whole cycle of a product is in many ways incomplete, open, and is not transformed into a new goods after end of life.

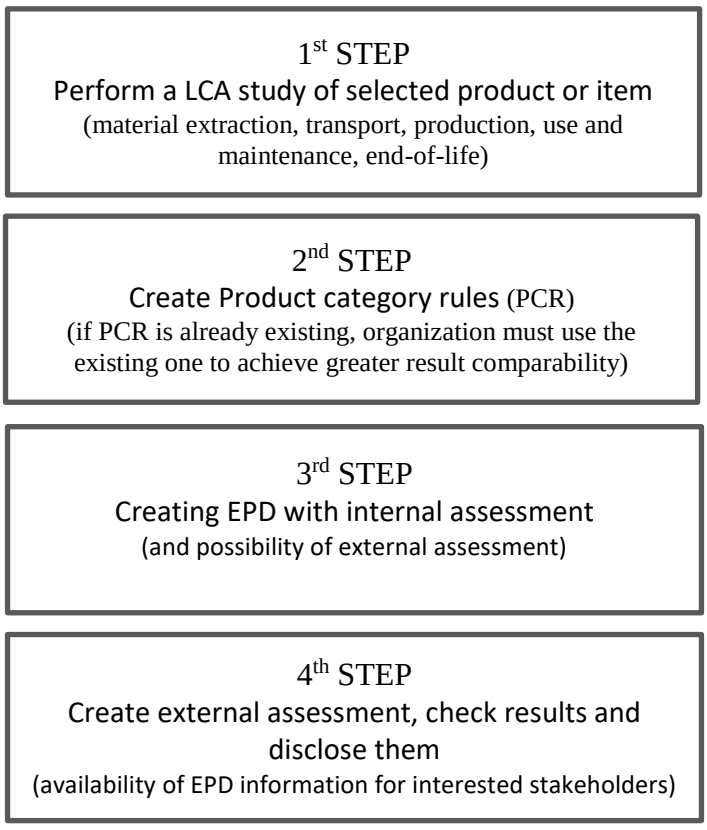
6.4 Environmental Product Declaration (EPD)

Environmental product declaration (EPD) could actually be introduced as the environmental equivalent of a technical datasheet. It is an independent and registered document that allow transparent and comparable information on products environmental life cycle impacts and present comprehensive information about the environmental impacts such as waste, energy use, water use and other resource use associated with a product (or service) in a standardised form. It is applicable for different companies and products since its main idea is to focus on life cycle assessment, meaning that the whole supply chain is again included in such evaluations. EPD clearly defines product composition, production processes, environmental efficiency, sources of raw material supply and relations with waste management. It is a voluntary ISO type 3 (according to ISO 14025:2006 standard) declaration that does not directly means that one

product is environmentally better that others but it means that it has evaluated and assessed information flow what is actually happening with this product through its life cycle phases (ISO 14025:2006, ZAG, n.d. and EPD International 2018).

According to ISO 14025:2006 and EPD International (2018) acquiring EPD is done in four steps as presented on Figure 16.

Figure 16: Acquiring environmental product declaration (EPD)



Source: ISO 14025:2006 and EPD International 2018

The term Environmental Product Declaration and its acronym as well as logo are registered within the EU and is valid for all EU Member States. It is mandatory also for some European structural project funding (Mikuš Marzidovšek 2009) and can be registered within the programmes such as International EPD System. It can be used for several applications including green public procurement and schemes for assessing building's sustainability. Due to lack of comparable information especially in construction sector (e.g. construction materials, buildings) the need for comparable information tool was identified in the EU to enable

comparison of different materials or building designs with life cycle perspective taken into consideration. The basic idea was to develop an information tool for communication between companies (B2B) however it can be used also for communication with final consumers (B2C) about products environmental performance. Since it is based on LCA with evaluation of impacts through the whole supply chain it is highly complex but also needed and reliable basement especially for construction sector where sustainable use of natural resources will have to be proven in the future. EPD is issued for the period of 5 years with the possibility of prolonging it if there were no changes impacting its environmental performance (ZAG, n.d.).

CASE STUDY 8: EPD as a tool for achieving environmental and economic benefits

An EPD could actually be introduced as the environmental equivalent of a technical datasheet and present standardized form of comprehensive information about the environmental impacts - waste, energy use, water use and other resource use associated with a product. It is applicable for different companies and products since its main idea is to focus on life cycle assessment, meaning that the whole supply chain is again included in such evaluations. On Table 4 three companies are compared – two (Squiggle Glass, 2017 and Wiesner-Hager, 2018) that already acquired EPD and one that could do get in the future (Nobis, 2018). Nobis is Slovenian office furniture producer that is focused in local material supply and has all the basics to start implementing ISO 14025 standard. They should first study their organization structure, business processes and supply chain. When all required data are gathered an EPD can be obtained and issued by different independent evaluators. Due to local raw material supply, very important issue – source of raw materials, is well documented and can bring advantage in obtaining EPD more easily than in case of imported raw materials without any information about its extraction, processing or even origin. At the end of life, their products could be re-collected and reused or recycled by the company. With the acquisition of the EPD company could gain additional economic benefits. Especially differentiation on a highly competitive market and achieving additional added value, just like Squiggle or Wiesner-Hager, are the most important two benefits.

Organization	***Squiggle (Great Brittain)***	***Wiesner-Hager (Austria)***	***Nobis (Slovenia)***

Sector	*Furniture production & sales*	*Furniture production & sales*	*Furniture production & sales*
Product	*Squiggle glass*	*Office desks, cabinets, drawers, other office furniture*	*Office desks, drawers, other office furniture*
Acquisition of EPD	*2017*	*2012*	*Potentially interested, not yet acquired*
Environmental protection standards and activities	*-Product idea (lifetime solution for paperless presentations)* *-Local production*	*-Environmental management (EMAS and ISO 14001)* *-LCA in accordance with ISO 14040*	*-High environmental perception* *-Focus on supply of local materials*

Table 4: Cases of business with acquired EPD and business potential for its acquisition

6.5 Forest Stewardship Council (FSC)

The Forest Stewardship Council (FSC) is an international, independent, non-profit organisation which, incorporating the views of all interest groups on a democratic basis, establishes global principles and criteria for responsible forestry, and uses these principles and criteria to develop standards for sound forest management. Key criteria for this are the cultivation of forest species that are appropriate to location, protecting precious habitats, banning genetically-modified plants and reducing the use of pesticides (FSC, 2019). Since it focuses on supply of raw materials, processing, etc. it is related with supply chain management as well as with bio-economy as a part of circular economy.

The guidelines for FSC certification are globally binding and transparent, and have been produced with the involvement of all the social groups that have an interest in forests. In putting together these guidelines, environmental concerns, social questions and economic needs are considered with equal weighting in open processes. The FSC logo presented on Figure 17 gives customers added value of having more sustainable resources used for their wooden, paper, paperboard etc. products (FSC, 2019). From supply chain management perspective traceability of raw materials is crucial. If the company wants to get FSC, they have to check that their previous suppliers till the primary product supplier (wood processing industry, forestry etc.) are also FSC certificated. For each tree that is cut down, forest industry must that a new one

will be planted. This enables sustainable use of resources and allows use of resources available to renew in biological period needed for a tree to grow.

FSC Chain of Custody certification verifies that FSC certified material is identified or kept segregated from non-certified or non-controlled material through this chain. To better understand, how all FSC and FSC Chain of Custody works, it is better to analyse one of the companies, which has all of the certification.

Because companies use a lot of paper, wood and related fabrics, produced out of wood and because environmental awareness is rising companies are sometimes forced to buy and use only FSC material. Carton packaging (e.g. TetraPak), books, envelopes, wooden furniture etc. are all cases of frequently certified products. In printing houses higher demand for printing on FSC paper is identified. Even though FSC paper can be 3-5 % more expensive, total product price is not impacted because the cost of paper is not that relevant in case of printed matter (books, magazines, journals etc.) So even though it seems, that to be FSC certificated is really hard, because the whole chain of distributors and suppliers should be certificated, it is possible and already well established practice of protecting forests and stop illegal forestry especially in environmentally sensitive areas.

Figure 17. FSC logo

Source: FSC, 2019

CASE STUDY 9: FSC in SIG Combibloc Obeikan
(adapted from SIG, 2016)

SIG Combibloc Obeikan is one of the world's leading system suppliers of carton packaging and filling machines for beverages and food. At up to 75 % of the carton content and pulp fibre obtained from wood is the main component of aseptic carton packs. And this is what makes carton packs fundamentally different from all other types of packaging used for beverages and long-life foods. So for this company to be environmental friendly and have a FSC certification is really important.

SIG Combibloc places great emphasis on ensuring that the wood fibres used to manufacture the unprocessed paperboard for its carton packs are traced from the forest source without interruption. To make certain that this can be done, the company have implemented a certified chain of custody (CoC) verification according to the FSC® standard (licence code FSC® C020428).

SIG Combibloc requires all its suppliers of unprocessed paperboard to operate production facilities that are certified according to the FSC Chain of Custody standard. This ensures that controversial wood sources can be avoided for the manufacture of the unprocessed paperboard. Tracking of wood fibres from forest of origin is guaranteed, and only wood from controlled sources or ecologically responsible forest management is used. [4] What is more SIG Combibloc is the first manufacturer of carton packs to have all its production sites world-wide certified in accordance with FSC's criteria for a continuous product chain of custody. This certification provides documentary evidence of the high environmental standards to which SIG Combibloc works. Obtaining its FSC CoC certificate enabled SIG Combibloc to be one of the first manufacturers to offer aseptic cartons carrying the 'FSC Mix' label.

Combining environmental labels is also becoming more and more popular, especially when organisation needs to consider products life cycle to make environmental improvements. It is possible to analyse the exact product and it’s lifecycle and include some relevant certificates and environmental labels into the process of environmental improvements. The materials for e.g. packaging come from FSC certified resources and can also be chlorine free, not chemically treated, compostable, without petroleum etc. So it means that if the company starts to be environmental friendly it becomes like a chain or rolling stone – just one certification is not enough and they are trying to achieve the best results in helping the environment, integrating eco-design and environmental life cycle thinking into the product design.

7 DISCUSSION ON ENVIRONMENTAL ASSESSMENT INFORMATION FLOW AND POSSIBLE SUPPLY CHAIN IMPROVEMENTS

To perform environmental performance analysis or to assess environmental impacts, concise data acquisition is a preconditioned. When considering life cycle perspective, data must be acquired on the completely different level that when assessing only environmental performance within the company's walls. Therefore cooperation of supply chain partners in additional environmental information flow is crucial. Many times these data include also information of a sensitive nature about the business of a company (e.g. supplier) which the company has a legitimate interest in keeping confidential. When SC manager starts with new business model to form closer cooperation between partners within the supply chain and manage its "greening", agreement on data disclosure within their partnership is urgent for efficient implementation of best possible measures.

Table 5: Comparison of information and performance factors in different approaches and labeling schemes

	LCA	**Ecodesign**	**EU-Ecolabel**	**C2C**	**EPD**
Life-cycle perspective	included	included	included	included	included
Environmental improvements	Just assessment	Basic idea is to achieve environmental improvements	Needed for acquisition and sometimes extension	Needed for acquisition and extension	Just certificate on environmental performance
Supply chain effect	Just assessment but gives insight about SC partners environmental performance (which to keep and which to replace)	Focuses also on SC partners' environmental performance (which to avoid or replace and which to keep)	Can impact suppliers	Can impact suppliers	Can impact suppliers
Marketing effect	Indirectly it can be used in marketing and communication with customers	Improvements can be used for implementation in marketing and communication with customers	Possible direct implementation in marketing	Possible direct implementation in marketing	Possible direct implementation in marketing
B2B or B2C approach	B2B and B2C	B2B and B2C	Especially B2C, also B2B	B2B and B2C	B2B and B2C

In Table 5 basic issues regarding environmental information within different studied concepts of environmental protection related on SC and considering life cycle perspective are cross-compared.

Life cycle assessment

LCA as the standardized assessment of environmental impacts through the whole life cycle has well determined required information on scope and margins of the study, inventory data analysis, assessing data on environmental impacts of inventory and interpretation of the results to create useful information for managers. However LCA itself only focuses on environmental assessment and do not actually require any activities related with environmental improvements, nor from the company performing LCA nor from their supply chain partners. Nonetheless companies that decide to perform LCA usually perform it to get sufficient information on their product's or service's environmental impacts and to focus on improvements in most potential focus areas that are many times hidden if life cycle perspective is not included and might be related with environmental performance of primary raw material, energy used in the manufacturing processes, decomposition etc. Consequently it can inspire the whole supply chain or at least a group of supply chain partners to make environmental improvements which are becoming more and more often also profitable (at least on a long run). It can be performed due to business requirements (e.g. if public tender demands EPD for materials included in procurement process) or voluntarily (e.g. if company wants to make environmental improvements and focuses on comprehensive environmental assessment first) and can also be used for marketing purposes however interpretation of results must be done according to the ISO standard.

Ecodesign

Ecodesign's basic idea is to minimize product's environmental impacts already in the design phase therefore information of products life cycle environmental performance are fundamental for effective implementation. LCA can be a starting point for ecodesign; however it is far from being the only possibility. Ecodesign questionnaires are more frequently used because they are simpler and most of the time less time and cost intensive than LCA. It can be successfully distributed among supply chain partners to gather required information however even eco-design questionnaires can sometimes ask to much from SC partners in terms of revealing information that one partner could consider as a business secret (e.g. energy used in production

process). Despite simplifications in comparison with standardized LCA, ecodesign questionnaires also enable good insight into life cycle related environmental impacts within the whole SC. Since its structure is divided into strategy for material sourcing, for production, for distribution, for use and for end-of-life phase it covers environmental impacts and possible improvements within the whole SC comprehensively. It can also include information on pre-ecodesign and post-ecodesign phase therefore it can easily be implemented in business marketing strategy to gain green oriented customers and to give signal to environmentally sound business on company's improving environmental performance.

Environmental labelling schemes

The whole proces of gaining one of the environmental labels or certificate begins with the company reviewing its products and its compability with the demands of gaining the certificate or label. If the product is appropriate for the certification, the company needs to select an accredited assessment organization, which then conducts a careful analysis. The data, which is then collected with the help of assessor is send to the acredited assessment organization, which decides if everything is according to the rules. If everything is alright, the company receives the certificate, after which it works with the institute in promoting the product, as well as improving its processes. After that, on certain period of time re-certification is needed (2 years for C2C and 5 years for EPD) with intention to review the reported progress and to keep awarded certificates or labels only to environmental performance market leaders. (Cradle to Cradle Products Innovation Institute 2018 ; European Commision 2018a ; EPD International 2018).

Requested information in all three cases are combined from data on environmental performance through the products life cycle. Some environmental labels also require exact information of products (or companies) state before and after acquisition of the certificate or label. The last is required also for the self-declarative labels, that are not standardized and do not require independent assessment and accreditation, to prove that environmental activities and improvements were really implemented.

Environmental labels can also be seen as a strong marketing tool to promote sustainable production and consumption, gain environmentally aware customers and enable priority in green public procurement as in case of City of Kolding.

All of these information can have positive or negative effects on SC partners. If partners (e.g. suppliers or manufacturers) are assessed to be of poor environmental performance they should be contacted and communicated about possible environmental improvements that are sometimes a precondition for acquisition of certain environmental label or certificate (e.g. minimization and substitution of hazardous materials at suppliers side). If they are not interested to perform improvements, SC manager must assess cost and benefits of avoiding or replacing such e.g. supplier or manufacturer with environmentally more sound partners which enable that the whole SC becomes more environmentally undisputable and allow them to enter into the ecolabeling scheme to improve companies' images within the whole SC, make environmental improvements also within the whole SC, increase products added value across its value chain and convince more green oriented consumers to buy or use their product or service.

8 CONCLUSION

Above described concepts, certificated, labels and ideas of greening the SC as well as cases and real business show that "greening" a SC is not necessary that complicated if well planned and organized. It is just about squeezing more economic and simultaneously also environmental benefits out of current operations. SCM is nowadays confronted with new challenges regarding just in time production, increased products variations, batch size one production series, shortening of products and services life cycles, fast changing environment as well as increased environmental pressure. Recently the last is becoming priority among SC managers and innovative ways of greening the SC are being investigated. In this chapter life cycle perspective as a prosperous concept for assessment of well known and hidden environmental burdens, ecodesign as a tool for environmentally friendly design of products and services enabling environmentally sound SC already in the products and SC design phase and environmental labelling schemes including life cycle thinking as potential tool for making SC more environmentally sound as well as for communication with customers are being examined. All of examined principles, ideas and labelling standards regarding environmental sustainability are at least partly in accordance with the concept of circular economy, promoting circular instead of linear flow of materials. Due to scarce and limited raw materials and awareness that the future wellbeing of societies as well as companies is related with nowadays environmental protection and performance these ideas are becoming more relevant than ever before. All of these principles are in favour of the idea that economic growth and environmental sustainability are not two contradictory but complementary goals that connects more and more stakeholders within the SC. It can be concluded that environmental protection is an interdisciplinary issue and it must be carried out on with tide cooperation of partners on different SC levels comprehensively to achieve the best results.

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