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CHAPTER 3

The strategic challenges of food logistics

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3.1 Intorduction – logistics in nutshell

In this subsection we will get acquainted with the specific logistical problems of agri-food supply chains. But for this we first present the general definition of logistics.

Logistics is the process that includes the planning, implementing and controlling of the the flow and inventory between origin and destination of products and services and related information,with the intention of meeting customer expectations.[1]

Logistics is therefore an extremely complex and diverse process system, the obvious aim of which is to ensure that the products and services provided by the company reach customers and direct users in the best possible way (in quantity, quality, place, time, inputs) that best meets the needs of consumers. The content of the „right mode" is mostly determined by the macro and micro environment, consumer expectations and the corporate strategy adapted to them. Above all this, however, are the two general criteria that are prerequisites for the long-term success of all organizational processes, including logistics[2, 3, 4].

Effectiveness expresses the ability of a given process to achieve its goal, to what extent it meets the expectations placed on it. Effectiveness mostly covers areas of appropriate quality, place and time. Effectiveness determines the satisfaction of customers and stakeholders in the process.

Efficiency expresses with how much effort the process can achieve the given result/effect. The efficiency objective function can be formulated in two approaches: a process is effective if it achieves the given result with the least possible input, or the maximum possible result from the given input. These two formulations show that only an effective process can be efficient, but effectivenes alone does not guarantee efficiency.

In the accelerated, difficult to predict and uncertain world of the 21st century, two new criteria that determine the success of logistics systems are increasingly coming to the fore.

By *sustainability*, we mean ensuring the current effectiveness and efficiency of our systems and processes without consuming or destroying our future opportunities and (natural, social, economic) resources.

Agility expresses the totality of an organization's ability to thrive, develop and grow in an unpredictable and rapidly changing environment[].

Logistics systems must therefore meet four general criteria in order to operate successfully: effectiveness, efficiency, sustainability and agility. These criteria are, of course, also valid when extended to the level of supply chains defined in previous chapters. How these general criteria are filled up with specific content depends heavily on corporate and supply chain strategies. Some possible examples are shown in Figure 1.

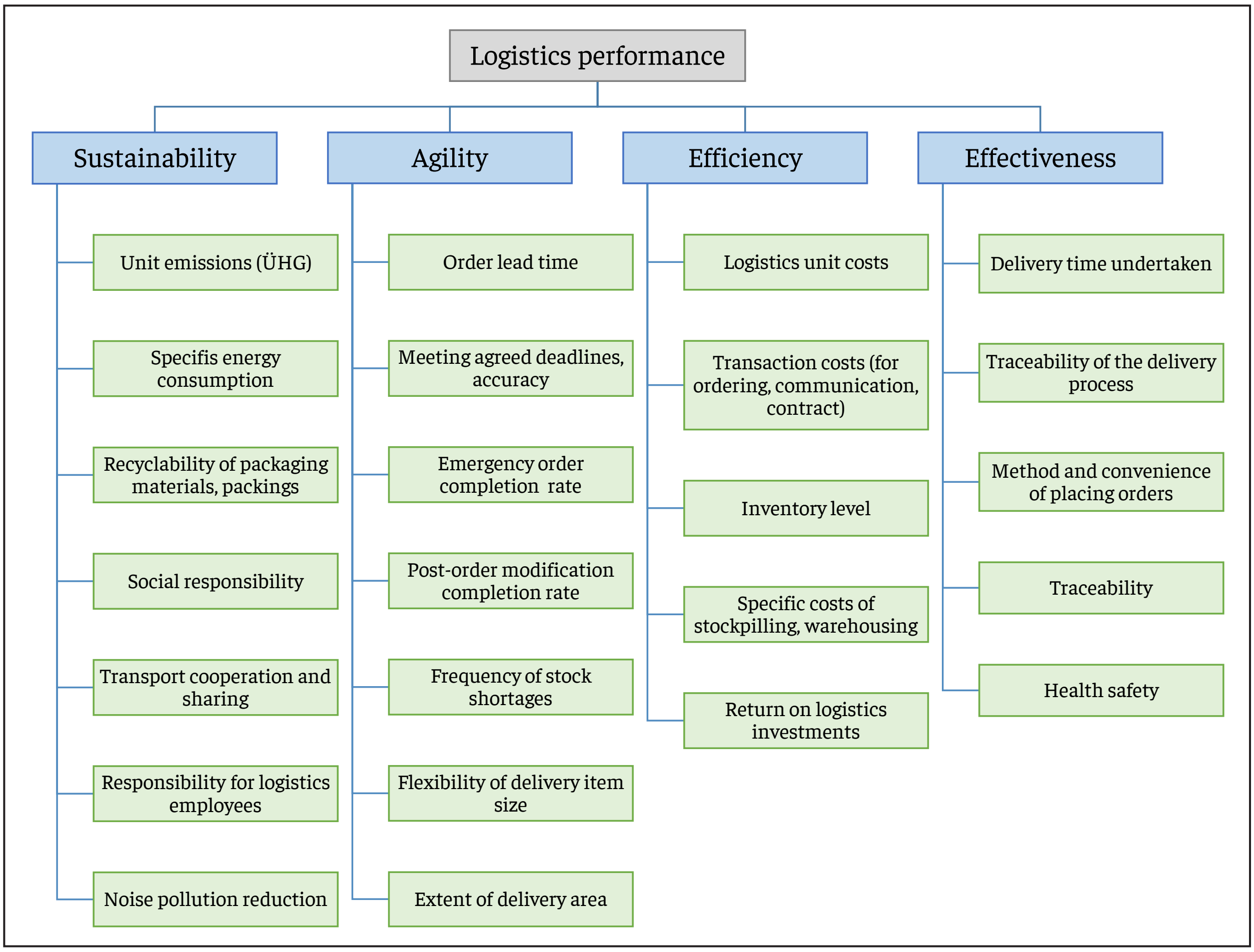

Figure 1. *Examples of logistics performance components*

Of course, logistics performance is realized through the provision of many complex logistics functions and processes. A complete logistics system includes the following components:

- site selection and network planning,
- freight transport and route planning,
- material management and order collection,
- customer service,
- production logistics,
- warehousing management,
- inventory management,
- information systems,
- e-commerce and e-logistics,
- inverse and waste logistics.

Since this volume is not intended for a logistics textbook (many of which are available on the market), we will not go into a detailed description of these functions. At the same time, we consider it important to draw attention to some specific features that relate specifically to agri-food supply chains. In the rest of this chapter, we will focus on these challenges.

3.2 Specific logistical challenges in agri-food supply chains

As in all product lines and sectors, the supply chain approach and the associated logistics toolsystem quickly appeared in the food economy.

The food supply chain is a system of organisations, persons, activities, information and resources involved in the production and transmission of food[9].

In this composite and complex system, the production and delivery of food to consumers is realized through the cooperation of several sectors with completely different structural and economic characteristics (for details, see Figure 2).

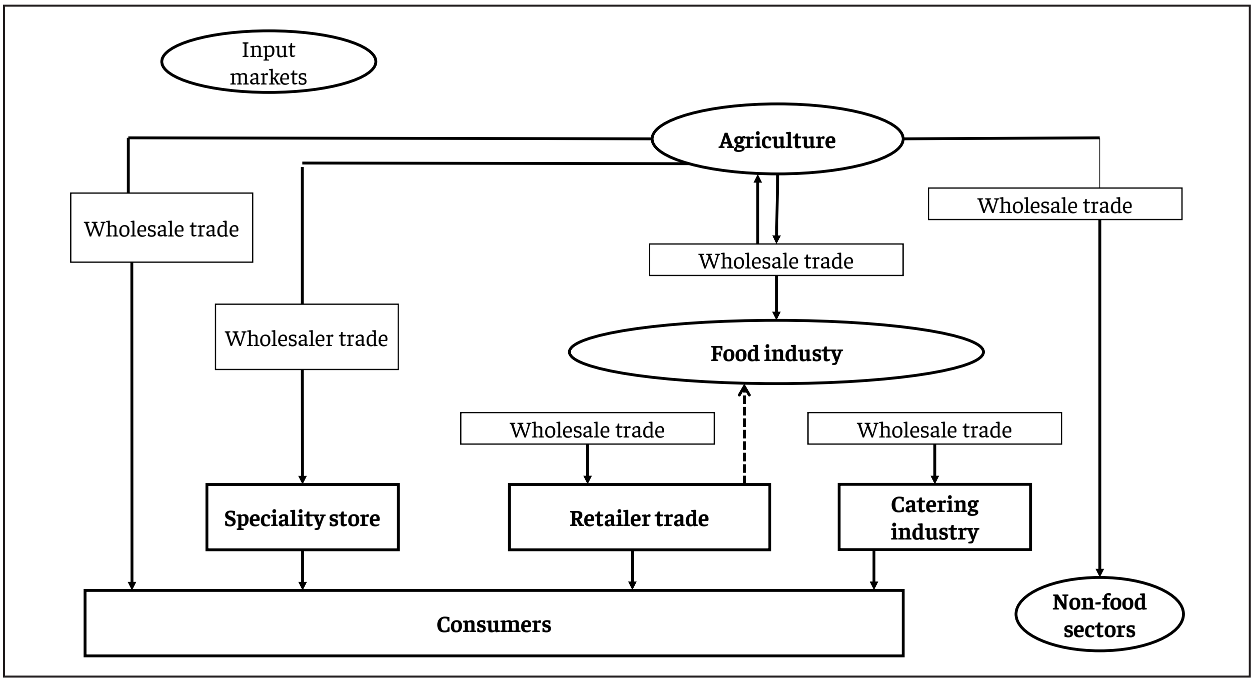

Figure 2. *Schematic model of the food supply chain*
Source: Bukeviciute, et al. [10]*, side 5.*

Businesses belonging to the agricultural, food, commercial and other sectors often have to deal with completely different logistical problems and challenges. Overall, therefore, we cannot speak of a single 'food logistics' throughout the supply chain, but rather of specific logistical problems specific to each part of the supply chain, which nevertheless need to be solved in an integrated and cooperative manner by the actors. The main logistical challenges are summarized in Table 1. In addition to the challenges, the table also describes the requirements for the logistics system to successfully respond to them.

Table 1. *The traditional challenges of agri-food supply chains*

Logistical challenges	Logistics requirements
Qualitative and quantitative fluctuations due to living organisms and proximity to nature.	Flexibility of logistics processes, building forecasting and warning systems, incorporating uncertainty into the planning process.
Perishability of fresh food.	Special delivery conditions, ensuring a short order cycle time.
Goods with a high specific weight.	Short transport routes, rail and river freight, where possible.
Variety and diversity of products.	Application of special transport vehicles and storage infrastructure.
Seasonal yields in crop production.	Building a warehouse network, purchasing to a global level.
Social demand for food safety and environmental protection.	Traceability of production and product information.
Product flow complexity.	Logistics planning, ensuring traceability.
Complex network structure, company size, and concentration differences.	Coordination and rationalization of supply and distribution.

Source: Self edit according to Verdouw et al.[11] *and Wajszczuk*[12]

During the 2020s, in addition to traditional challenges, logistics 4.0 requirements modelled on industry 4.0 will become increasingly important in agri-food supply chains. New industrial technologies and their possible applications in food logistics are summarised in Table 2.

Table 2. *The appearance of industry 4.0 in food logistics*

Industry 4.0 components	Possible applications in food logistics
Robotics and automation	Autonomous vehicles and drones for inventory monitoring and management in food warehouses.
Big Data	Optimization of delivery routes, demand forecasting, collection and analysis of customer feedback, inventory management, capacity planning.
Simulation	Delivery scheduling, warehouse planning, planning of transport capacities, planning of lead times.
System integration	Monitoring from farm to fork, demand forecast,
IoT – Internet of Things	Quality management, monitoring, capacity tracking, route planning, hazard detection and prevention.
Cybersecurity	Increasing food safety, risk management
Cloud services	Synchronization of logistics systems, real-time data flow within the chain.
3D printing	Tailor-made food production, reduction of transport and packaging costs.
Augmented reality	Training of logistics specialists, warehouse management systems, support of maintenance operations, quality control, warehouse planning,
Block chain technology	Tracking shipments and products, reducing the administration of international shipments.
Artificial intelligence	Supporting supplier-managed inventory management, supporting cooperative inventory planning and management.

Source: Self edit according to Jagtap et al.[13]

3.3 Customer service level and performance measurement in food logistics

3.3.1 Key performance indicators of customer service level

The level of customer service can be measured by a number of indicators, which should be measured in a complementary manner in parallel. With the help of a system consisting of several indicators, it is possible to get a general overview of the operational effectiveness and efficiency of the company's logistics system. However, it is important to know that these indicators, when viewed alone and statically, do not give information about the "goodness" of the logistics performance of a particular company. Conclusions can be drawn from the value of indicators of the customer service level if values from previous periods are available or if we know the relevant performance of competitors in the same industry with similar characteristics for the period under review. Knowing these, we can already get a relatively accurate picture of the development of the logistics performance of the company under consideration and its position in the logistics competition. In the following, the most important indicators are described based on Gelei[14].

Availability of the product (on time, in full, OTIF)

Shows the percentage of orders shipped in the given period that were successfully completed on time and in accordance with the conditions set out in the order.

$OTIF = \frac{R-HR}{R} \times 100\%$, where

R = the number of orders, order lines, or quantity of products ordered in a given period;

HR = number of incorrectly executed orders, order lines, or quantity of products ordered

Already from the explanation of the formula it can be seen that the OTIF indicator can be interpreted at several levels. We can define it at the level of orders, order/picking lines, or even product quantity. The calculation at different levels is presented through a simple example.

Example 1.

We want to determine the OTIF indicator for 3 orders for a small business engaged in artisanal cheese production. Details of the three orders and their completion are given in Table 3.

Table 3. *Basic data for example 1.*

Order number	Ordered items	Completion
1.	Goat cheese smoked on beech tree 10 pcs Basil soft cheese 20 pcs Gouda cheese 10 pcs	By the deadline, according to the order
2.	Goat cheese smoked on beech tree 20 pcs Peppery soft cheese 20 pcs	After the deadline, according to the order
3.	Lump cheese 10 pcs Mozarella in his own whey 20 pcs Spicy orda 30 pcs Chilli semi-hard cheese in olive oil 20 pcs	By the deadline, mozarella 5 pcs less, Spicy orda 10 pcs less

According to the data in the table, the values of the three levels of the product availability indicator:

- At the level of orders. One of the three orders was delivered after the deadline and one with quantities not matching the order, meaning that two of the three orders were completed incorrectly. OTIF= 33,33%
- At the level of order items. the first order contained three items that the business completed flawlessly. The second order was not completed by the deadline, so both items are considered incorrect. Two of the four items in the third order were delivered in the wrong quantity. In total, 4 out of 9 order items were completed incorrect. OTIF = 55,56%
- At the level of order quantity. The first order was for 20 products, which the business completed correct. In the case of the second order, all 40 products are considered incorrect, as they could not be delivered on time. The third order was for 80 products, compared to which we were able to deliver 15 pcs less. In total, therefore, out of the 140 products, 55 pcs are considered incorrect. OTIF = 60,71%

Average order lead time (RÁI)

This refers to the average time between receiving orders and completing orders. It is calculated by continuously measuring and recording the individual lead time of each order over a given period of time (from the arrival of the order to the delivery and handover of the ordered item). The average order lead time for a given period is defined as a simple arithmetic average of the individual lead times of orders received during the period.

Delivery time reliability (SZHM)

In some cases, customers do not necessarily judge the performance of suppliers based on the speed of delivery, but on the basis of meeting the promised deadlines. Therefore, the percentage of all orders that we can deliver to customers within the promised deadline is an extremely important competitive factor. Keeping the SZHM indicator at the proper level contributes to the establishment of customer confidence, thus increasing the proportion of returning customers. Numerous studies have shown that the marketing costs associated with returning customers are a fraction of the marketing costs associated with acquiring a new customer.

$SZHM = \frac{R-NHSZ}{R} \times 100\%$, where

R is the number of orders received during the period under review,

NHSZ is the number of orders delivered after the deadline.

Damage rate (SA)

During the delivery process, there are several critical points where the transported goods may be damaged. The risk of damage is an integral part of the transport of goods, thus the proportion of products delivered in poor quality.

$SA = \frac{STÉ}{ÖKÉ}$, where
STÉ is the value of orders fulfilled without damage,
ÖKÉ is the value of all delivered orders.

3.3.2 Application of performance key indicator systems: basics of the SCOR system

The essence of key indicator systems is that they evaluate logistics performance not with a single indicator, but with a system of indicators consisting of several key indicators. A general feature of these systems is that indicators are classified in a hierarchical order according to specific company/sector needs and into higher-level categories. Thus, at one time, it is possible to derive from the individual indicators performance indicators by category, from which, in turn, we can determine the system performance indicator. Category-by-category and system aggregation is not a general requirement. There are systems in which there are no derived indicators.

The real advantage of performance measurement can be achieved if the indicators are measured not only for one's own, but also for the processes of major competitors. This so-called benchmark activity allows us to be able to identify the position of our own performance in the ranking among competitors.

Of course, for a performance measurement system so sophisticated and composed of many indicators, no general, globally applicable scheme can be given. While frameworks generally exist that can be adapted to all sectors and corporate environments, they must be sufficiently flexible to adapt to the specificities of the company carrying out the implementation. One of the most famous such frameworks developed for supply chains is the SCOR (Supply Chain Operations Reference) system. The SCOR system has been developed by several companies and interbranch organizations since the mid-1990s and is currently maintained and developed by a non-profit organization, the Association for Supply Chain Management. Since its launch, the system has spread very rapidly, being popular mainly among large companies with a global supply network. SCOR itself does not serve as a mere performance evaluation system, but rather as a complex strategic management system, however, it is most often encountered in connection with performance evaluation.

The processes defined in the SCOR framework cover the business processes that occur throughout the supply chain. The standardized elements of the system can be easily adapted to the supply chains of any product path, whether simpler or more complex. The basic model of the system is based on six main management processes[15]:

- *Plan.* Planning processes include defining resources, requirements, and the communication chain in line with business goals. This includes developing best practices for supply chain efficiency while considering compliance, transportation, assets, stocks, and other necessary elements of the SCM.
- *Source.* Source processes ensure the procurement of goods and services in order to meet the planned or actual market demand. This covers the entire procurement and supplier management.
- *Make.* Processes that produce marketable finished products are included, including total production management, material requirements planning, and facility and asset management.
- *Deliver.* Includes order management, freight traffic and distribution processes related to the delivery of finished products.
- *Return.* Backflow processes are related to the management and receipt of products and information that come back from customers or suppliers. This includes also post-delivery customer support processes.
- *Enable.* This includes supply chain regulatory processes such as business rules, capacity management, provision and management of data sources, contracts, compliance with regulations, standards and risk management.

The system offers a total of 250 different metrics to measure supply chain performance, which can be divided into five different performance characterizing categories: reliability, responsiveness, agility costs and asset efficiency. Businesses that use SCOR decide for themselves which performance characterizing categories to prioritize and which to settle for an average performance. Standardized metrics allow system users to compare their own performance with a wide variety of businesses.

Also to help standardization performance is measured at three different levels in the system:

- *Level 1:* the level of configuration of the main processes (plan, source, make, deliver, return, enable), where the scope of the main processes is defined, including geographical scope, industry and customer segments, stakeholders and context (market, industry and macro environment).
- *Level 2:* the configuration of the supply chain by forming process groups within the main processes. Defining geographical scope, line-of-business segments and products can also be important here. Level 2 metrics are multi-process aggregated indicators.
- *Level 3:* here we already identify elementary processes within the subgroups of level 2, and then assign metrics to each process. These level 3 metrics should be clearly attributable to the aggregated process groups and indicators of level 2.

To close the subsection, we present two examples from the international literature of the results of level 1 and level 3 planning.

An international research team conducted a case study of the SCOR model of the global supply chain of air service catering company Emirate Kitchen Flight Catering (EKFC). The three-level planning described above is presented on the basis of the case study. The supply chain level 1 main process map is shown in Figure 3.

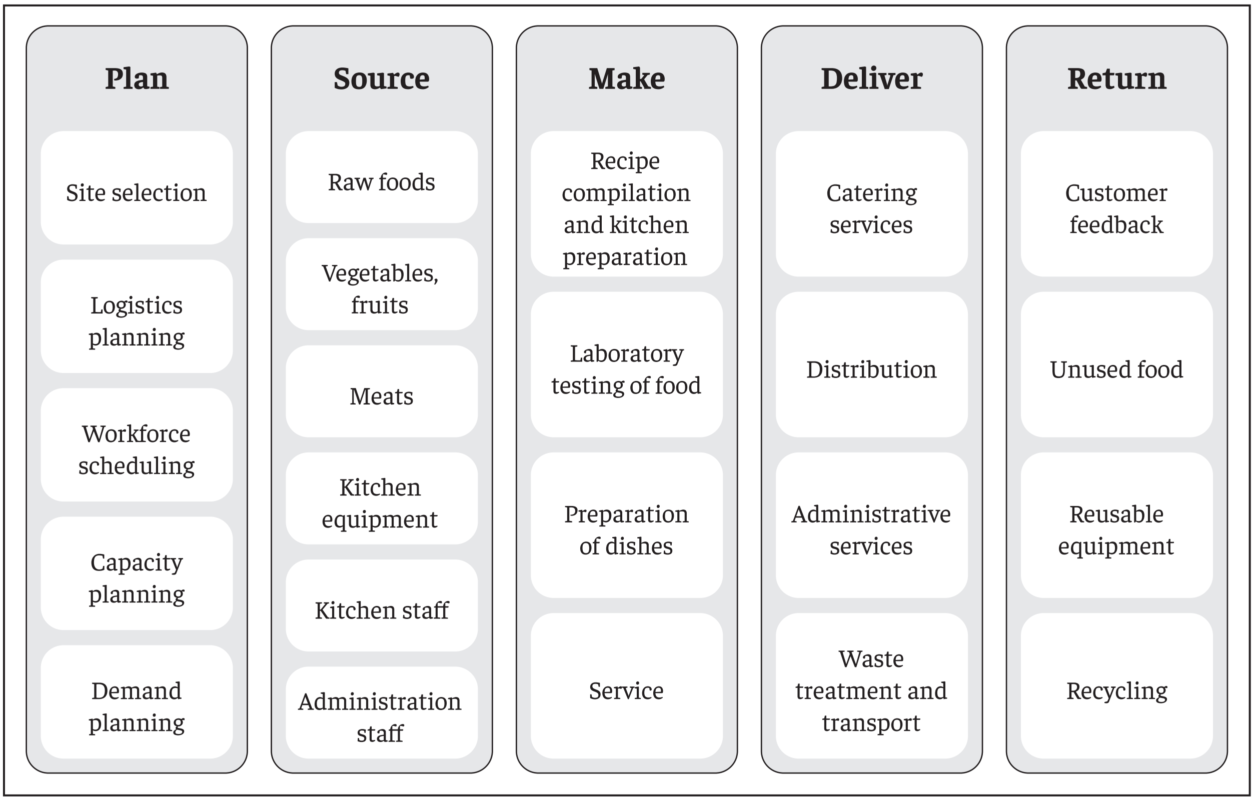

Figure 3. *SCOR Main Process Map (Level 1) at EKFC*
Source: Sundarakani et al.[16], side 489

Figure 3. thus shows the groups of processes within each main process, which can also be called the level 1 main process configuration. During level 2 planning, detailed process maps of process groups and aggregate indicators measured at the level of process groups are then presented. We do not want to present the details of process map making here, more information and examples on EKFC level 2 process map making are available at the link below: https://ro.uow.edu.au/dubaipapers/991/.

An example of a system of level 3 elementary metrics is given from another study. The Indonesian Bureau of Logistics (Bugol), maintained by the Indonesian government, is responsible for organizing and operating the distribution of food critical to national food safety. One of Bugol's activities of such strategic importance is the organization of rice procurement. An insight into the SCOR metrics system for this activity is provided in Figure 4.

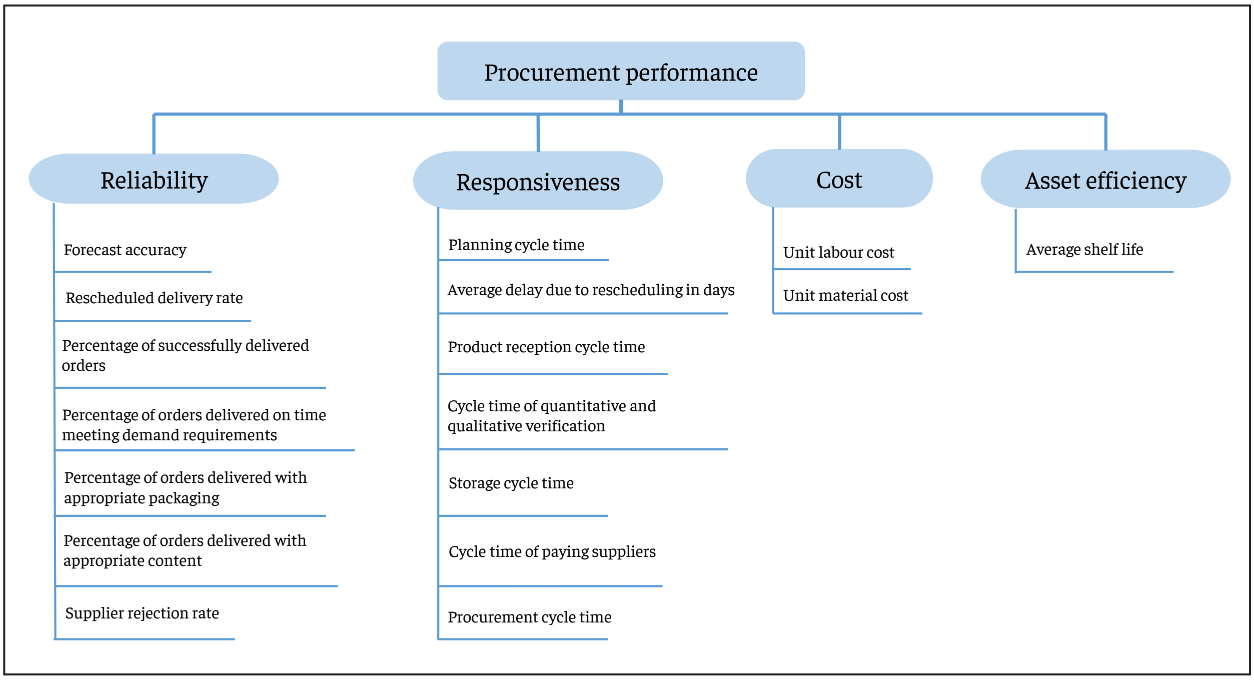

Figure 4. *Key metrics (SCOR Level 3) in the rice purchase of the Indonesian Bureau of Logistics*
Sources: Self edit according to Novar et al.[17]

Details on the explanation of each metric, other elements of the SCOR system are available at the link below: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8708814.

3.4 Procurement management in the food economy

3.4.1 Ensuring the supply of inputs to agricultural production

The starting point for the material needs of the food supply are the inputs necessary for agricultural production. In both crop production and animal husbandry, the current assets that most determine production results can be well defined.

Chemicals and propagating materials are a very significant factor in the production of food of plant origin. The logistics processes of input supply, as in the agri-food supply chain as a whole, are quite complex, since material and information processes take place in these markets between organizations of different sizes and activities with the most diverse economic characteristics. The situation of the supply of propagating material is further complicated by the fact that about 28 percent of the grain seed need is produced by agricultural holdings themselves.

From the above described, it naturally follows that the wholesale sector plays an important role in the supply of inputs, in particular the logistical importance of input-side integrators stands out. Commercial firms that typically reach medium and large company sizes integrate farmers “from two sides”:

- on the one hand, as input distributors, they act as a bridge between chemical manufacturers and seed producers and the large number of agricultural holdings using their products;
- on the other hand, they buy up and market the produce of the partner producers under cultivation contracts.

The activities of integrators go significantly beyond trade. Within the framework of cultivation, a number of additional services (consultancy, input financing, training, information management) are provided to producers. Integrator services now include logistics services. The market-leading integrators have their own nationwide distribution network, which includes their own fleet of vehicles, a regionally divided warehouse system, a system of regional centers and a network of stores that also provide nationwide coverage. With their help, it is easy to not only minimize order fulfillment times, but also to deliver the sold inputs to the warehouse.

The organisational structure, which is divided by business unit and geographically, allows flexible adaptation to the needs of local users. In parallel, with the help of internal integrated ERP and information systems, distribution processes can be optimized at the company level. Smaller, regionally important input distributors also place great emphasis on logistics services, including freight organization. The economies of scale disadvantage compared to their competitors engaged in nationwide distribution are reduced by strategic alliances, the creation of joint ventures. Through the agrochemical joint venture, the owner companies are also able to implement distribution with nationwide coverage.

The largest share of the turnover of feed mixtures, premixes and feed supplements is carried out by feed manufacturing and distribution companies operating in industrial-large-scale conditions. Most of these manufacturers are present in Hungary as members of trans- and multinational groups. Their distribution activities are characterized by duality: in addition to selling directly to larger production plants, they also carry out retail sales through a network of contractual partners. Their distribution activities are complemented by the professional consulting service. This group also includes importing companies engaged in purely commercial activities.

A possible distribution scheme for feed supply is illustrated in Figure 5. A relatively new way of retail distribution is mobile sales by vans, which can be a suitable solution primarily for backyard and small goods-producing family farms.

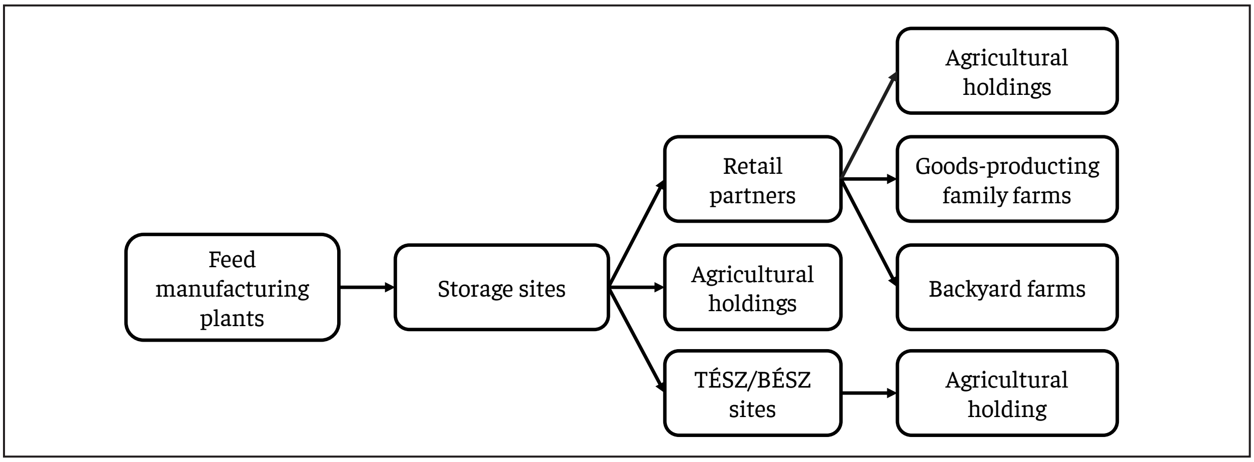

Figure 5. *Distribution scheme of feed manufacturer large companies*
Source: Self edit

The third group of input supply coordination consists of food processing companies. Although these entities are not directly involved in the input market, their involvement in this area may be justified in several respects. The quantity, quality and method of use of the input materials used have a major influence on the following factors of agricultural products

- specific yield, security of production volume;
- quality and quality homogeneity;
- cost of its production;
- nutritional indicators.

3.4.2 Ensuring the supply of raw materials in the food industry (incoming logistics)

A significant part of the products produced in agricultural production is not sold as final products and is bought up and processed indirectly or directly by the food industry. A very significant part of the added value is only then created. Thus, one of the central moments of the domestic food supply chain is the delivery of agricultural products of plant or animal origin and live animals from the production site to the processing site. The main steps of this can be summarised as follows.

Supplier selection

The supply of raw materials can be ensured from several sources. Acquisitions can take place directly from producers, cooperatives, small wholesale companies, integrators. In Domestic practice, these sources of supply are often present simultaneously in the supply base of a single processor. Since our accession to the European Union, there has been a clear rise of integrators and cooperatives. The reasons for this[18, 19]:

- these organizations concentrate a large supply volume, which reduces the complexity of the supply network;
- the provision of services to producers to increase production security and thus supply security (e.g. consultancy);
- a significant number of cooperatives and integrators take on some of the tasks of contact, communication, storage and transport scheduling and organisation;
- through these organisations, both the quality assurance of the production of raw materials and the traceability of the products purchased are better ensured;
- seasonal fluctuations in supply can be eliminated;
- the qualitative homogeneity of the raw materials is also controlled and required by the intermediary organization.

Overall, therefore, cooperatives and integrators simplify the procurement process in many areas. However, choosing the right suppliers is still a rather complex process, which is based on multi-criteria assessment. The most important of them are[20, 21]:

- value for money offered by the supplier;
- supplier size (quantity of sheet), transport distances, the existence of a contract (vertical coordination) and quality certification;
- Choice of transaction management structure. According to the way in which transactions are organized between suppliers and buyers, so-called governance structures can be distinguished. Structures can be classified according to whether free market or hierarchical nature dominates the management of transactions.

The advantages of the free market mechanism are flexible adaptation to price changes, autonomy for organisations and, from the customer's point of view, the possibility of competitive tendering of suppliers. The disadvantage, however, is that the partner's performance and market behavior can be little controlled and sanctioned. Conversely, with perfect integration, coordination is much easier, but adaptation to price changes is less effective. Domestic medium and large companies in the food industry are increasingly deciding to attract suppliers to the ownership interest, or possibly to acquire them altogether. In recent years, there have been several examples of the construction of groups of companies ranging from input supply to food processing. The risks of supply can be significantly reduced by this.

Organization of the supply of raw materials

The coordination of the delivery of the raw material to the place of use can be the responsibility of both the supplier and the customer. In today's practice, the transport of products of plant origin is typically carried out by suppliers, and the transport of products of animal origin and live animals is typically carried out by customers. In many cases, the obligation to bear costs and perform coordination tasks is separated (e.g. the supplier takes care of the transport organization for the time scheduled by the customer, for which he subsequently receives logistical reimbursement). Food companies that take on the costs and coordination of freight transport are also characterized by outsourcing of raw material transport activities. The downsizing of own fleets achieves significant cost savings and improved transport performance indicators.

Quality acceptance of incoming freights and establishment of compensation

For the vast majority of agricultural products purchased, there are numerical and measurable quality indicators that affect the productivity and efficiency of processing. It is in the interest of both the agricultural and food sectors that, based on the results of correct quality acceptance, suppliers who achieve better indicators than the average can receive premization and surcharges commensurate with their performance during compensation. There are product paths (e.g. sugar, milk) where quality-based premization works according to a relatively well-developed system, but unfortunately there are also some (e.g. pig product path) where all the technical conditions are given, yet only a part of the processors have developed a real quality-based benefit system.

3.5 Organisation of short agri-food supply chains

Nowadays, more and more are seeing the light of day in relation to local products and short food chains (RÉL). In Western European countries attention to local products began to gain strength decades ago. Thanks to this, consumer demand for regionally specific, even multi-generation, conventionally produced food products has emerged. The main challenges related to RÉL are presented using the article by Horváth, Szerb and Csonka[22].

3.5.1 The definition of short agri-food supply chains

The concept of a short food chain in the literature is defined by the authors in different ways. According to Renting et al. (2003, p. 394) „... inter-relationship between actors directly involved in the process of production, processing, distribution and consumption of food."[23]

Short food chains were divided into the following types by Jarosz[24] and Ilbery-Maye[25] based on their spatial extent and sales mechanisms:

a) Direct sales

There is a direct relationship between the producer and the consumer at the moment of sale. The condition for re-buying is the right quality of goods and a good experience at the time of purchase. The place of sale can be: roadside point of sale, farmer's living yard, home delivery, farmers' market, web store, pick yourself, guest table.

b) Community marketing-based sales

In the course of social marketing-based sales, the relationships between the RÉL actors are represented in an institutionalized form. There are many studies on producer or consumer cooperative shops created as a result of social marketing, which provide an excellent opportunity for producers to appear on the markets. In addition, various forms of direct delivery to local catering establishments, mass catering establishments or local product stores are also popular. In recent years, thematic festivals and farewells have become increasingly popular, which can also be a point of appearance for producers.

c) Extended supply chain

In the case of the extended supply chain, the producer is not in direct contact with the consumer. One or more intermediaries enter the chain, whose task is to transmit the relevant information in the channel from the producer to the consumer. The most important such information is the exact origin of the food (e.g. food from a family farm, from permaculture, organic, national park or regional food).

3.5.2 Benefits of short food chains

Benefits to producers

According to all international surveys conducted in community-supported agricultural systems, the responses of the farmers surveyed showed a lower than average age and higher education[26, 27]. Similar demographic values can generally be seen by producers in other supply chains. Farms are usually small, the average plant size does not reach 10 hectares[28, 29]. In short supply chains, farmers are characterised by flexibility and openness to innovation[30]. It is a difficult task to transform the plant to such a level that it becomes suitable for participation in the community-supported agricultural system, as consumers expect the continuous provision of fresh and varied food. In order to achieve this, plants switching to RÉL supply must develop both efficient and flexible operational operation and a form of communication. This is partly the reason why it is mainly young and skilled producers who are engaged in alternative forms. The fact that joining an existing network requires from the farmers a wide range of skills and a tendency to innovate also benefits young and skilled producers.

Trust is an essential condition for the emergence and success of a short supply chain[30]. Traditional and farmers' markets in large cities attract different layers of farmers. In the case of traditional markets, higher prices, instant cash payments and habits are more important, whereas in the case of farmers' markets the influence of the same factors is less motivating. The farmers' market sells farmers who can manage a larger area and have a wider range of products and additional investment plans. Membership in cooperatives and participation in informal collaborations also have an impact on market vending decisions.

Benefits to consumers

A short supply chain meets the needs of two types of consumers[29]. One type basically prefers a conventional food supply and only occasionally takes advantage of the opportunities offered by a short supply chain. The other type is a completely purposeful consumer for health, ethical or other reasons and specifically tries to avoid the usual general solutions.

Serious sacrifice and a change of mindset on the part of consumers are needed if they want to buy only (or mostly) local food. Examples of such sacrifices include the abandonment of fruits that do not grow locally and other foodstuffs, or the periodic avoidance of food that, due to climatic conditions, can only be produced periodically locally. In addition to these, one should not forget about the abandonment of the convenience provided by supermarkets, where everything can be bought in one place, is constantly available to consumers, and in many cases even cheaper.

Benefits to society

Rural development also plays an important role for local economic development for short food chains[31, 32]. Local producers can become suppliers to institutions with a local public function, with the support of central or local government. The more distant goal of these public catering programs is also to improve the health of children from lower-income families. From the point of view of the producer, the great advantage of such programs is that the state order can form a predictable, secure market. On-site processing increases employment and has a multiplier effect, which can further strengthen the local economy. Another advantage of the programs is that school classes can actively participate in factory visits and excursions, and they will be able to use the experience gained there in the school or even in the home garden, thus completing environmental education.

3.5.3 Logistics problems in short supply chains, in particular environmental challenges

The environmental impacts of short food chains are double-edged. It is logical and confirmed by a source of literature that short transport distances related to the local food supply (either in the transport of live animals or in the distribution of finished products) reduce both transport costs and emissions associated with transport processes. An important environmental advantage of local food systems based on geographical proximity is that transport distances are reduced. However, this benefit may be eliminated by the travel overhead for consumers. The realisation of the benefits therefore requires an efficient and high-quality organisation of consumer service (e.g. forming an environmental and user-friendly delivery). Even if special storage conditions are ensured (e.g. refrigerated storage), there is a possibility that the specific energy consumption and the emission of harmful substances of the RÉL exceed that of even imported products. However, other researchers stress that, when measuring energy use at the system level, the energy efficiency of well-established and managed international supply chains may even be better than local food systems with a small transport distance, but operating in a decentralised manner and capable of achieving smaller sales volumes. The balance could be clearly tilted towards local supply if the costs of covering the transport distance between producer and consumer are more borne by the customer, as the chances of organising multipurpose journeys on the customer's side are significantly better. In this case, of course, the travel costs incurred are not only "charged" for the transport of the purchased product, but are also divided among the other purposes related to the travel. This type of transaction, which takes place at the site or near the site at a point of sale, can take place within the framework of direct sales by producers or community production programmes typically linked to a settlement. However, there is a serious risk of such production systems that processing capacities created for the supply of a single producer or a narrow community operate for a significant part of the year with low utilisation and overall poor efficiency.

Transporting a product from the place of its production to designated markets or food centres is the most complex and cost-effective process, and thorough, accurate and precise planning is required to ensure the smooth operation of this process. Transport costs are a very important aspect for companies, they can transport as many products as possible at as little cost as possible, so transport vehicles must be used to the maximum in terms of their carrying capacity. Thus, even a large amount of products can be profitably transported to closer settlements. Logistics and resources spent on a short supply chain are ignored or underestimated, despite the fact that logistics has been decisively improving the quality of traditional supply chains for years. In long chains, there is not only one type of logistics organization, since it can vary depending on the method of supply and the destination of the product. Warehouses perform more key functions in the supply chain, storing the product for a longer or shorter period of time at the right temperature, or labeling and repackaging it so that it can be further delivered to the target market.

The problems illustrated here are serious, but not unsolvable. The most important question is whether the organisational and infrastructural background and production volumes behind short food chains are ensured, with which an efficient logistics system can be developed. An excellent example of this is the Székely product trademark created by the Hargita County Council in Romania. The trademark system satisfies the conditions of both local food systems and short supply chains. The system also includes food, industrially produced non-food products, handicrafts and intellectual products. Effective outreach to consumers is ensured by a multi-element sales system.

The Council organises a monthly farmers' fair. On it, consumers reach products in a concentrated way in space and time. The cost of traveling to the fair and the emission of harmful substances are not only charged for the purchase of RÉL products, as other tourist and cultural attractions accompanying the fair are also an important part of the supply. Fairs are organized at regular, predictable intervals, so that the purchase can be well scheduled. Regular local fairs are complemented by the organization of participation in domestic and foreign festivals and trade fairs, so that the products are occasionally "released" from the local market, increasing the viability and competitiveness of production. The third element of the sales mix is sales to local stores and chain stores. These commercial companies, while guaranteeing a secure market outlet, have an efficient logistics system that allows fast, cheap and low specific energy transport and storage. Thanks to the use of such conventional sales channels, the trade mark system can provide producers with a stable market and economic development. Although this is a compromise in terms of maintaining the RÉL nature of the trademark system, it also allows for local development of the system. In recent years, significant processing capacities have been established in Székely Land to increase the added value of products, with the help of self-resources provided by the steadily increasing sales turnover and with the involvement of tender resources. Increasing the degree of processing further improves the competitiveness of the products of the trade mark system.

3.6 Stocks in the supply chain

It is a legitimate consequence of material flow processes that the flow is interrupted and stopped from time to time. When tangible materials stand in a given place for a given period of time, "waiting" stocks are formed.

By stocks we mean all material goods, products that are available in the company at a given time[33].

Of course, it is not that the material flow just stops "spontaneously" and the stocks suddenly "form" on their own. Conscious and managed inventory activity is necessary because the individual stages of product production and the sale of finished products consist of stages that cannot be precisely matched in time and space. Rationally formed stocks thus serve to bridge gaps in space and time.

Stocks are material goods that a company accumulates in order to use them in its subsequent production and sales processes.

Excellent examples of the significance of time differences are provided by the food economy. In the case of plant-based foods, the raw material from agricultural production is typically produced once a year in large quantities, while the market demand for the processed food product is continuous throughout the whole year. The same is true for feed for farm animals. Another example is agrochemicals, which are one of the most important input groups in crop production. They are manufactured continuously for economic and capacity utilisation reasons, but are typically used on a campaign basis.

3.6.1 Classification of stocks

Stocks can be classificated in several ways. In this subsection, the most commonly used classification methods are presented.

The essence of *accounting classification* is that the breakdown is distinguished by the origin and form of appearance of stocks. By origin, stocks are divided into two large groups: purchased and own production stocks. Subgroups by form of appearance are summarized in Figure 6.

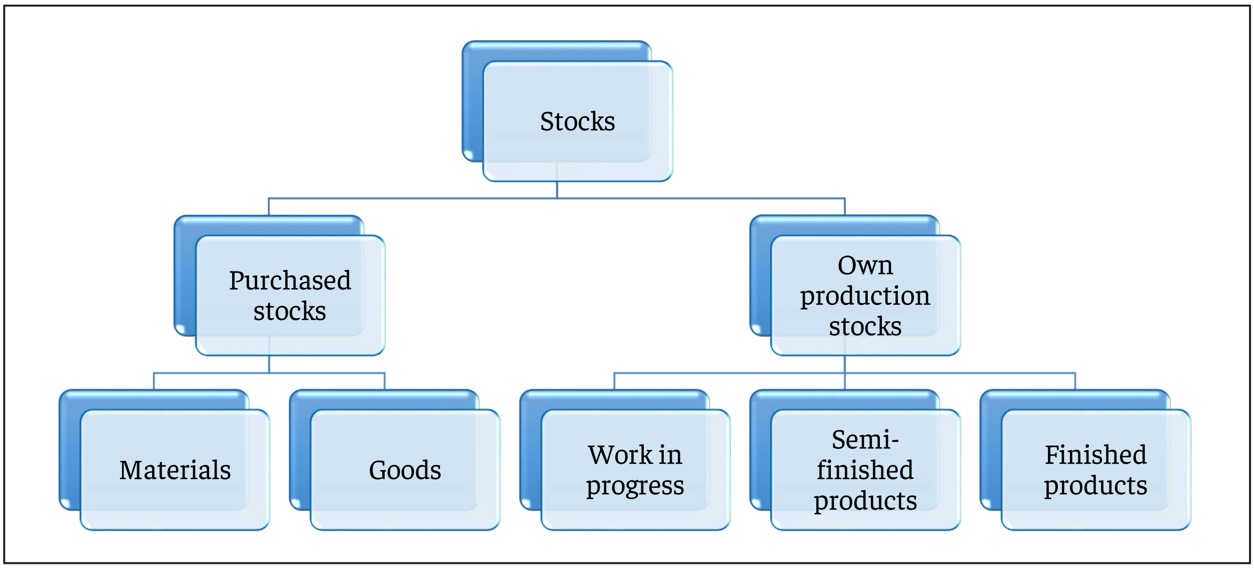

Figure 6. *Accounting classification of stocks*

The essence of another classification option, the so-called *functional classification* is that stocks are classificated not according to form of appearance or origin, but according to their role in economy. This also means that the division into groups is carried out at a completely different level: it makes sense to carry out the functional division within a stock keeping unit.

Stock Keeping Unit, SKU: a stock element which is clearly distinguishable from all other stock elements according to given characteristics and within which there are units of stock which are homogeneous according to those characteristics and which cannot be further broken down[34].

The design of stock keeping units can be carried out on the basis of a number of properties. Some examples for characteristics: manufacturer, material, size, packaging, warranty, product description, etc. For example, in a commercial unit, a stock keeping unit could be an egg of size "M" from farm "X" from deep litter-loose holding.

Within the stock keeping units, we are obviously not able to form additional groups based on the form of appearance. The purpose of the functional division is to determine, for a given SKU, how the stocked quantity or value is distributed across stocking goals.

The most important stocking groups by stocking goals are as follows[35]:

- *Planned stocks* are designed to prepare for forecast and estimated changes in supply and demand. The amount of stock included here is able to meet the demand and needs for SKU in addition to "normal course of business", smooth internal and market processes. It is easy to see that the planned stocks are burdened with significant risk. We can only estimate the demand for each period. There are inaccuracies in our forecasts, and unexpected orders, unpredictable demand run-ups, and other disruptions (e.g., temporary disruptions to stock refill) may occur at any time.
- Preparation for unexpected demand events and supply disruptions is provided by *security, also known as buffer stocks.* They can be perceived as a kind of safety margin, with which we are able to "weather" extraordinary events, to ensure a continuous flow of products.
- In many cases, it happens that for a particular production process, the flow of material occurs in stages, cyclically, from the preventive process. In such a situation, *cycle stocks* ensure production security between two supply periods. In another approach, a volume of stock that is sufficient to meet the demand between the time between the order placed for refill and the receipt of the ordered item can be called a cycle stock.

3.6.2 Stocking cost

The costs incurred in connection with stocking can be divided into three parts, depending on which processes in stocking they arise.

1. Stock keeping costs (often mistakenly referred to as warehousing costs) arise in connection with the storage of stocks in a broad sense and the associated additional processes. The main costs here include[36]:

- Opportunity cost of capital invested in stocks. The capital lying in the form of stocks in the warehouse may not be used for other profitable activities or developments, nor can it be committed to financial investments until it is returned. The resulting loss of profit is not shown as an explicit cost, however, we must nevertheless take it into account between the expenses of stocking.
- Costs incurred in connection with warehousing processes. These include depreciation or rent of warehouse buildings, personnel costs of warehouse employees, warehouse energy consumption, or costs of register and guarding.
- Loss due to a decrease in stock value: damages resulting from physical wear, deterioration, obsolescence, theft, or other deterioration.

Stock keeping cost elements are typically in linear relationship with the stock value: the higher the stock value in warehouses, the higher the stock keeping cost will be. The indicator that expresses the correlation numerically is the stock keeping cost rate. The stock keeping cost rate expresses, for a given period (e.g. a year), the number of units of stock keeping costs per unit stock value over a given period.

2. Ordering costs incure in connection with the refill of consumable stocks. Typically periodic expenses that are independent of the order quantity. The most important costs included here:

- costs of contact with the supplier;
- administrative and communication costs of order preparation;
- transport costs;
- costs of receipt and quality control of incoming shipments.

Part of the stocks (semi-finished and finished products) are not ordered by companies from external partners, but are produced by themselves. In this case, too, a kind of "internal ordering" cost arises. This is nothing more than the cost of switching production capacities (e.g. production lines) to the production of a particular product. In the food industry, for example, it is usually the case that a product has variants with several flavours. At this time, variants with different flavors are produced on one production line, producing one version at a time. During the switch from one flavor to another, downtime and the associated loss of capacity are to be considered as losses.

3. Stock shortage cost arises when we are unable to satisfy a customer order due to lack of available stock. In the case of an unsatisfiable customer order, we need to distinguish two cases according to whether the customer is willing to wait until his order is fulfilled at a later date.

- If the customer does not cancel the order, the company must do everything possible to satisfy the demand as quickly as possible. By this we mean the priority production or purchase of the requested product(s) from an external source, as well as the emergency delivery of the order item. However, there are also administrative costs for maintaining the order.
- The situation is even worse if the buyer cancels the order. In this case, we have to count the loss of collateral for the missed sale as an immediate expense.

The list shows that identifying, measuring and recording stocking costs is not always an easy task. Many of the cost elements described here are implicit (hidden) and the separation of explicit costs is only possible with a well-operated management information system.

3.7 Inverse and waste logistics

3.7.1 Defining inverse logistics

Inverse logistics is located within waste management logistics, it got its name from the fact that the goods (which in this case are waste) have the opposite direction to the direction of flow of the product production. Inverse logistics is the development of a waste supply/processing chain (WSC) within the extended supply chain (ESC). Through this activity, it supports the reduction of environmental pollution, the return of production factors to supply chains, contributes to the development of circular farming, the reduction of the ecological footprint and helps to ensure the concept of sustainable development. Another approach is that inverse logistics is a broader category than waste management logistics and environmental protection is just one aspect of the concept. There is also an approach whereby it means expanding the satisfaction of individual customer needs (traditional logistics processes) with the social need (inverse processes) to collect packaging material, car wrecks, etc. left over from use for utilisation or disposal[37].

Grouping can be carried out according to several criteria based on the literature, a summary of which is presented in Table 4:

Table 4. *Classification of inverse logistics*

By source[38]	By extent[39]
Economic inverse logistics	Micro level
Legal-environmental inverse logistics	Macro level

Based on the source, two types of inverse logistics can be distinguished, which are as follows:

- Economic inverse logistics: Collection and reuse of primary packaging waste e.g. deposit system for beverage bottles.
- Legal-environmental inverse logistics: Collection of types of waste that are not used in their original appearance but as a raw material or energy source, e.g. other agricultural waste.

3.7.2 The concept of green logistics and sustainable agri-food supply chain

In the food economy, the problem of labor shortages and distances triggered the pursuit of new technological solutions relatively early on. Due to these needs, remotely controlled, satellite-controlled machines appeared in the fields, but the category of global products also emerged. These consumer demands require bridging the problem of the availability of a range of products without time (seasonal products displayed per season) and geographical limitation.

As one of the world's largest food producers, the European Union is currently able to influence global production, thereby affecting food prices. Behind the improvement in agricultural productivity, the development of monoculture, irrigation, advanced implements or even pesticides can be highlighted. However, these factors of production place a much greater burden on the environment than in the past, e.g. biodiversity is reduced, nitrogen pollution increases, etc. and the overall energy efficiency of production is reduced in order to achieve higher food production yields. The big question for the next period is therefore: How can the current demand for food continue to be met so that the environmental impact of agricultural production can be reduced?

According to data published by the FAO (Food and Agriculture Organisation of the United Nations), a third of all food produced in the world does not reach the consumer[40]. In the European Union, 87.6 million tonnes of food are wasted every year[41]. In addition to saving the cost of an unnecessarily wasted resource, saved food provides an opportunity to moderate the problem presented above. In view of the above, the EU has decided to halve food waste per capita by 2030 and become climate neutral by 2050 (European Green Strategy)[42]. Among the campaigns that are becoming more and more widely known nationally, the "Live to the full" campaign can be said to be outstanding, for example, which draws attention to raising awareness and supports food rescue with posters, recipe books and other actions.

Although the effectiveness of this type of campaign (reaching end consumers) is difficult and may fall short of expectations, it requires much lower costs than changing other components of the food supply chain[43].

According to a study, about 70% of recycling processes are associated with logistics costs, therefore the proper structure and efficiency of the logistics system is very important. Within recycling processes, additional sub-processes can be divided, these can be[44]:

- the process of collecting spent products,
- the disassembly process,
- the selection process,
- the distribution process and the
- waste logistics process.

Environmental protection and logistics are in connection at several points, including[45]:

- Environmental damage associated with logistics activities,
- Coordination of infrastructure and quality of life in urban development,
- Participation in waste management,
- Participation in the operation of the production chain and waste chain.

Logistics activity itself causes environmental damage, such as the burdens associated with transport, factors related to the collection of goods, factors occurring during storage and distribution. To eliminate them, we can see examples from short-term solutions to long-term planning, e.g. rationalizing the distribution system or introducing new solutions. Logistics also plays an important role in settlement development, since in addition to economic aspects, the living conditions of the people living there are equally important. Logistics can complete processes also when performing the specific tasks of waste management, while its role in the operation of supply chains is also indispensable.

According to a Hungarian study[46] assessing the practical implementation of inverse/green logistics, a large number of companies are already using some less environmentally harmful method, e.g. reuse. However, no possible environmental solutions are used in transport, e.g. use of a route optimization program, use of hybrid vehicles with eco-engines, etc. This was due to the significant cost difference, even though a significant number of the organisations involved in the study declared themselves committed to sustainable development.

As an example, the inverse logistics processes of wine packaging materials are presented by 4R research (Reduction at the source, Replacement, Reusing, Resycling)[47].

Table 5. *The inverse logistics processes of wine packaging materials by 4R research*

Name	Description	Example
Preventive task		
Reduction at the source	Reduction of proportions/quantity of conventional raw material	Label reduction
Replacement	Replacing traditional raw material with an environmentally friendly alternative	Cartons made of environmentally friendly corrugated paper
Reusing	Reuse of materials	Reuse of compartments
Follow-up task		
Resycling	Processing and recycling of materials	Use of wine barrels for other tasks

Despite the fact that agricultural/industrial waste is regulated by a large number of legislation, the producer still has a fundamental influence on the amount and management of waste. Performing preventive tasks is always more efficient than follow-up task. The first of these is when the proportion of traditional raw materials can be reduced or waste can be prevented by reducing the amount of raw material In wine-sector processes, the need for raw materials for bottling wine can be reduced if smaller labels or bottles with fewer raw materials are used. Solutions where compartments are replaced by cartons made of environmentally friendly corrugated paper can also be effective, but it is already an improvement if the compartments are not disposable, but are constantly reused to perform the original function. In the event that the product has lost its original function, but still has usable material, it may be worth choosing its processing instead of producing a completely new product.

There are also good examples of long-term planning. In many cases, it is already taken into account in packaging design that material handling is the biggest cost carrier of logistics, so many goods are sold immediately from pallets, for example at large retail chains such as Tesco or Lidl. With this conscious design, for example the manufacturer can save a lot of packaging materials, as well as make delivery faster and reduce warehousing work.

In Italy, support was given at the legislative level for ‚0 km products' aimed at creating short supply chains[48]. The concept was based on producers being able to sell goods to consumers through direct sales, which motivated a reduction in logistics costs and a boom in local products. Setting a good example, the use of „0 km products" was an advantage in the selection process for food procurement tenders in the region, but in public institutions and mass catering, part of the annual use had to include products of this type.

There is also a case where food waste is handled with an IT solution[49]. At the Sofitel Hotel, the discarded food items are not only sorted, but the amount and cost of them are recorded with a specially designed software called Winnow. With the chosen method, real-time data are available to guide which areas require intervention and targeted actions.

The Szatyor Bevásárló Közösség embodies a grassroots initiative. The implementation of the principles of localization and sustainability is ensured by the basic concept, on the basis of which there is no stock of goods accumulating „stock", the collection points ensure only the service of the pre-placed demand-based order. A maximum distance of 70 km between the place of production of the food and the end-user is allowed, thus short transport distances contribute to reducing costs when purchasing local quality products.

The above examples, whether from below or from above, highlight good practices that suggest a positive vision for the future. The will to adapt technological solutions is proven, all that remains is to strive for availability and affordability.

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