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INTEGRAL TRANSPORTS IN AGRICULTURE

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Abstract. *The topic of this paper is the analysis and comparison of different transport systems in agriculture, which together form one unit, namely integral transport systems. In addition to all existing transport systems, emphasis is placed on the two most represented and important systems of integral transport of agricultural and food goods, namely the transport of perishable foodstuffs by road (cold chain) and ship transport of agricultural and food products, and the most important transport routes of the world and the European Union with an emphasis on the Republic of Croatia. The transport of perishable foods by road is carried out by specialized trucks, and the globalization of the market requires more efficient distribution, especially for products that require controlled temperature regimes. The flow of products in the cold chain is reduced to three basic factors, namely storage, transport and market space. The most important function of the cold chain is to deliver the product to the final customer without damaging the product in any way. Ship transport of agricultural and food products is of great importance due to the large volume of the ship (ship transport of bulk cargo - grain), where large quantities of bulk cargo or grain are safely delivered to the final destination - ports and silos. For these two most represented and most important systems of integral transport, transport routes are of crucial importance, and for the world, that is, the European Union, they are the trans-European transport network (TEN – T) and international corridors in water transport.*

Keywords*: integral transport, transport systems, routes, requirements*

INTRODUCTION

Integral transport is a method of transport manipulation in which the goods are not loaded directly onto the means of transport but are stacked on pallets or in containers, so that together with the goods they become a load that can efficiently and rationally be taken over by means of all forms of transport, i.e. all transport branches. Integral transport is a technology that, by inserting technical means between the load and the means of transport, consolidates the load, and thus the application of appropriate mechanization, without touching the goods on the entire transport chain "from door to door", except twice - during loading and unloading. (ŠUMANOVAC et al, 2011., STOJČEVSKA, 2017., GAVRILOVIĆ, 2022.)

The property of integral transport is that there is no transshipment during its development, but instead complete transport units are transported together with the cargo. At it calculates which form of transport is the most profitable. Integral transport should ensure that the goods are not loaded directly onto a specific means of transport, but are stacked on pallets or packed into containers. Pallets and containers organized in this way, together with the loaded goods, become cargo that can be efficiently transported by all forms of transport. (LABUS, 2016., MARTINOVIĆ, 2017., MAJETIĆ, 2022.)

Transport of agricultural food goods in the European Union

Land or road transport is a very significant and integral part of the entire system of all branches of transport, which at the same time complement each other and enable the transport and transfer of passengers and goods by sea, rail, river, air and pipeline types of transport. Good and the degree of economic development of the country. Shipping goods flows are the basis of global economic development and the progress of individual continents, regions and countries. Therefore, being involved in an intensive maritime trade flow is imperative for any country eager for rapid and strong economic development. (JUGOVIĆ et al, 2010.)

Trans-European transport corridors, transport corridors whose function is transit, that is, they connect the space of the European continent with the rest of the world. Trans-European corridors include all corridors whose beginning or end connects the European continent with the rest of the world, either by air, sea, road or rail. (BUMBAR, 2015.)

Rationally organized traffic or transport is a prerequisite for successful and efficient business and operation of the entire economic system, especially in its supply of raw materials and in the expeditious shipping and distribution of manufactured goods to consumer centres and consumers themselves. (ČEHKO, 2019.)

Ship transport is the main carrier and initiator of trade exchange in the world. It takes place along maritime transport routes that connect large industrial, traffic and trade hubs and their ports, where ship goods flows are formed. At the same time, the intensity and quantity of maritime goods flows in today's century have become a measure of the efficiency and usefulness of transport, involvement in the international division of labour. (JUGOVIĆ et al, 2010.)

Transport of perishable foodstuffs and grains by land and inland waterways of the European Union

Perishable products are those products for which there is an obligation to maintain special conditions within the distribution chain in order to preserve their original quality and ensure the expected lifespan during distribution. Perceiving temperature as an important phenomenon in the realization of transport does not represent a major difficulty, since it is understandable what impact exposure to unadjusted temperatures can have for certain types of, for example, fruit or meat products. However, temperature, humidity or vibration, as regular occurrences in the technological process of acceptance and shipping, are not the only elements that can adversely affect the authenticity and quality of the items being transported. In terms of the duration of the process, it can have greater adverse effects. Therefore, it is possible to accept the fact that these items of transport are, first of all, time-sensitive, and then temperature-sensitive. Table 1 shows the prescribed temperatures during the transport of meat and meat products (CVITKOVIĆ, 2019).

Table 1

Temperatures during road transport of meat and meat products (Cvitković, 2019)

Types of meat	Maximum allowed temperatures during transport (°C)
Fresh meat	+3
Frozen meat	-12
Deep frozen meat	-18
Minced meat	+2
Meat products	+4

The cold chain represents the process of handling temperature-sensitive products, within all the processes that logistics includes, where all involved participants and their actions are key to maintaining a correct cold chain. The carelessness of just one of the participants in the distribution system within the cold chain is sufficient to reduce the quality of the product and the impossibility of distributing it to the market due to endangering the health of the product. This leads to increased costs, but also to the dissatisfaction of end consumers in the search for sought-after but unavailable products. In accordance with the above, a company operating on the market can thereby negatively affect its position. (ČEHKO, 2019).

Table 2 shows the flow of products in the cold chain, i.e. the three most important factors, namely storage, transport and market space.

Table 2

Product flow in the cold chain (Filipaj, 2020)

Storage	After the production is completed, the product is stored in the space provided for it, until the moment when it needs to be transported to the desired market area
Transport	Transport of the product itself, depending on its type and shipping specifications, is carried in one or more means of transport intended for that purpose
Market space	Depending on the type of market space, it is necessary to store the product again until the moment of its actual use or consumption

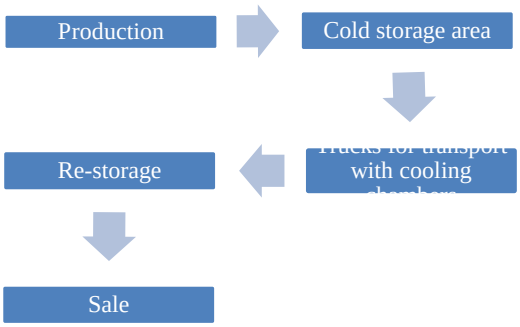

Figure 1. Cold chain processes (Filipaj, 2020)

During the ship transport of grains, grain as well as some other bulk cargoes have a natural inclination angle of 35°. Due to the very easy movement of grains in the warehouse during transport by sea, special treatment and special caution are required during loading. Until special ships for transporting bulk cargo appeared, grain was transported in the classic way in classic ships, so of course, the problem of moving the cargo in the warehouse arose. The classic ship had straight horizontal walls, and the surfaces inside the entire warehouse could not be filled and leveled. In addition, faster loading and unloading of cargo is enabled. Minimal load alignment is required after loading as well as during loading. In order to start loading grain at all, the basic element that needs to be known is the load stacking factor, which is shown in Table 3. Knowing the capacity of a certain warehouse, it is easy to calculate how much space a certain amount of well-stacked load will take or how much load can be loaded in an individual warehouse, and how much free space there will be in a partially filled cargo warehouse. (Bielić, 2004.)

Table 3

Grain stacking factor

Type of grain	Stacking factor of grain sacks *ft*³/3	Stacking factor – scattered *ft*³/3
Corn	54	49
Barley	60	54
Wheat	52	47
Beans	Changeable	Changeable
Rice	52	48
Sunflower seed	Changeable	Changeable
Oats	74	66
Malt	70	60
Flax seeds	58	61

(Bielić, 2004.)

Grain stacking factor (Table. 3): base unit cubic meter (*m*³/t) per ton or cubic feet pervton (*Cuft/t).* Converting *m*³ in *Cuft*/t = *m*³ 0,028; Cuft/t in *m*³/t = *Cuft*/t x 35,88. (BIELIĆ, 2004).

Table 4

Other requirements for grain and seed transportation
(http://www.unizd.hr/Portals/1/nastmat/Tereti%20u%20pom_pr_/Tereti%20skripte(s%20dodatkom%20za%20prijevoz%20UPP).pdf)

Embarkation	In sacks or combined
Stacking factor (*m*³/t)	1.30
Preparations before embarkation	The warehouses must be dry, cleaning and degreasing of the bilge covers. If the ship is not built as a bulk, it is necessary to build bulkheads according to special requirements
Measures during disembarkation	Supervision of loading, especially near the end to align and fill the entire space. If several species are loaded, they must be separated with an unstretched canvas
Measures during transport	The load needs to be ventilated. Information about this should be entered in the ship's logbook
Recommendations	Wet and unripe grains must not be loaded. Wet cargo increases in volume, heats up and gradually rots
Dangers	From the movement and expansion of wet cargo. Movement occurs due to lying down (30 cm and more)

The most important transport routes of the world and the European Union are the trans-European transport network (Figure 2.) and the VII. The Pan-European Corridor (Figure 3.), better known as the Danube Waterway. The function of trans-European transport corridors is transit, that is, it connects the space of the European continent with the rest of the world. The fundamental goal of the Trans-European Transport Networks (TEN-T) is the geographical and economic convergence of parts of Europe through the development of roads, railways, inland waterways, airports, seaports, ports on inland waterways and traffic management systems. The

aim of the Commission's TEN-T program is interconnection, interoperability and continuity of services, especially on long routes and across borders, by providing financial support for the implementation of important transport infrastructure projects. (BUMBAR, 2015)

The trans-European transport network consists of nine corridors: Baltic-Adriatic, North Sea-Baltic, Mediterranean, Middle East-East Mediterranean, Scandinavian-Mediterranean, Rhine-Alpine, Atlantic, North Sea-Mediterranean, Rhine-Danube. Each of them must include three types of transport infrastructure, pass through three member states and two border crossings. The Republic of Croatia is located on two corridors of the transport network, the Mediterranean Corridor and the Rhine-Danube Corridor. The Mediterranean Corridor connects the south of the Iberian Peninsula, crosses the Spanish and French Mediterranean coasts, passes through the Alps in the north of Italy, then enters Slovenia and continues towards the Hungarian-Ukrainian border. (https://promet-eufondovi.hr/eu-prometni-koridori-i-ten-t/)

Figure 2. Trans-European transport network (https://www.portnews.it/wp-content/uploads/2018/05/BBT-TEN-T-Korridore-Nov_2017_EN.jpg)

The basis of international transport corridors in inland waterway transport is the VII. Pan-European Corridor. It is also the main internal transport water corridor. It is also called the Danube waterway because it represents the course of the Danube River, which is the second largest river in Europe and is navigable over a distance of almost 2.415 km. It connects ten countries: Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Moldova and Ukraine. In addition, it connects Western and Eastern Europe via the Rhine and Main rivers, and the Rhine-Main-Danube canal, and the North Sea with the Black Sea. (BUMBAR, 2015.)

The total length of classified waterways in the Republic of Croatia is 1016.8 km, of which 740.2 km are waterways on which commercial navigation is possible. The Danube River in Croatia has a total length of 188 km, while 137.5 km is navigable. (MAGLIĆ et al, 2013.)

Figure 3. VII. Pan-European corridor - Danube waterway
(https://www.authenticvoyages.com/uploads/1/1/7/8/117821287/danube-river-cruise-map-2021_orig.jpg)

CONCLUSIONS

In this paper, two types of integral transport systems, i.e. their requirements, are analyzed - the transport of perishable foodstuffs by road and the transport of grains by ship. Taking into account the development of transport routes of the European Union with an emphasis on the Republic of Croatia, transport by land and waterways are two very profitable, fast and reliable integrated transport systems. The exceptional road connectivity of the European Union guarantees the safe transport of perishable foodstuffs by trucks to their destination. The European Union is connected by inland waterways, and with this, ships can be fully used to transport grain from one end of the continent to the other.

The reliability of European Union transport routes is very high, therefore farmers, suppliers and other parts of the agricultural transport industry have no problems with the requirements they must satisfy when transporting agricultural - food products, in this case - perishable foods and grains.

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