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QUANTIFYING THE COSTS IN RIVER TRAFFIC SYSTEMS

SUMMARY

The quantification and types of costs in the river/tourist transport can be approached from different viewpoints.

In river transport, the respective division into individual groups or types, as compared to the total costs appears to be of interest.

Apparent is the interdependence of individual costs and the level of utilisation of ship capacities (during a pleasure voyage).

The basic costs of transport in river (liner) shipping are, thus, the costs of ship's liner voyage, at average utilisation of the capacities corresponding to the long-term anticipated demand for ship space and specified profit, as well as the costs of capital.

In the system of tourist/river transport. the costs involve:
- total fixed costs,
- total variable costs, and
- total voyage costs.

All these groups include their sub-types in relation to ship voyage, in quality and quantity terms.

1. INTRODUCTION

Traffic on inland navigation routes falls into the category of the so called traditional traffic aspects and segments of industry and tourist trade, that has always had a major role in the process of development of society and civilisation.

Although the development of rail and at a later point of time road traffic reduced somewhat the importance of river traffic, with the passing of time it has experienced invigorated growth as well as that of the tourist destination along its navigation routes. This aspect represents the most rational and efficient long distance transport i.e. navigation.[1]

It possesses a number of economic, tourist and utilisation advantages, as compared to other transport industry segments. Particular reference should be drawn to transport costs, that according to some surveys in Germany come to 3.9 pfennigs in river transport, 13.8 pfennigs in rail transport and 24.1 pfennings in road transport per ton kilometer.

Regarding the construction of traffic infrastructure, no massive investments have been made, while it is possible to transport major quantities of freight at the same time. With respect to energy consumption, it has been worked out that 1 HP is used in carrying 4,000 kg in the liner (tramp) shipping system, 500 kg in rail transport and 150 kg in road transport.

Further advantages of river transport include: (a) longer operation life of vessels, (b) no major space requirements, (c) minor environmental pollution, in direct relation with a higher yield from the tourist trade, (d) advanced safety, and (e) navigation routes are less affected by damage and other (wartime) hazards.

From the aspect of mass transport and long-haul transport, the respective advantages can be considered from several viewpoints, as: (a) energy, (b) transport and (c) economy/tourist trade-related. It has been worked out that by using one liter of fuel one ton can be transported over 127 km by oil pipeline, 106 km by river, 84 km by road and 1.6 km by air.

With respect to transport capacities[2] the river transport has precedence over the rail and in particular over the road transport. Over the same period of time, a 500 car train must be utilised in the process of carrying 5,000 tons of freight by rail, or 250 trucks for carriage by road (on the routes more than 30 km long), while the same quantity of freight is transported by river (liner shipping) on barges sailing in convoy.

Fixed costs (FC) have a share in total costs (Tc_{tran}) of transport of 1 ton of freight, of 61% in rail transport, 50% in road transport and some 30% in river transport on the average.

It has further been computed that the proper costs of infrastructure refer to 61% in rail transport, 50% in road transport and as little as 10% in river transport.

In addition to the mentioned advantages, the river transport (liner shipping) exhibits also some deficiencies, to be primarily ascribed to its dependence upon weather conditions (low and high water level, freezing/formation of ice on waterways, etc.), limitation of the unit capacity of a vessel by the most disadvantageous clearances, the transport on liner routes takes longer as compared with other transport aspects, etc., in the long run assigning it (in the example of coun-

tries with advanced transport) the place within the transport system that viewed realistically belongs to it.

Considering its advantages and some deficiencies the river transport system takes a major place in the transport industry, not only in our country, but also in the overall world transport industry. In Germany, for instance, it has a 25% share in all transport. In the European Union member states, it reports a share of above 100 tkm, or in other words, its share equals the output of both the German (59 mlrk/tkm) and the French (51 mlrk/tkm) railways.

2. THE SYSTEM OF RIVER (LINER) TRANSPORT

From the aspect of different methods of tariff (fare) fixing, market influences, different aspects of operations management, as well as of different earning conditions, the river shipping industry[1] can be defined and considered as the *liner shipping* and *tramper shipping industry*, while the liner shipping according to the subject of transport involves (a) freight and (b) passenger services.

The costs[3] of ship's voyage refer exclusively to the liner (river) freight shipping, within the scope of the river navigation system.

The ships operating the liner services[4] are not concentrated in one place. The shipowner engaged in this transport offers a part of the ship's space for different types of cargo, in different ports of origin, with the objective of providing cargo transport to several ports of destination. Transport services are offered (supplied) at given intervals, over a longer period of time, and on given navigation routes. The utilisation of the fleet in liner shipping involves several characteristic features:

- the ship in the port of origin does not offer or supply the whole shipping capacity but only a portion of the available capacity;
- the offered or supplied assortment of goods in the port of origin does not involve one typical kind of goods or a single shipper but different goods and different shippers;
- the linkage of the ports of origin (i.e. loading), destination (unloading) and possible trans-shipment on given liner service routes is carried out at given frequencies (according to the established schedule);
- the river shipping company assigns several ships to given navigation routes, i.e. by using its organised fleet of vessels.

The shipping contract in the river shipping is the bill of lading, as different from "charter packages" in use in tramper shipping and possibly sea tanker transport.

In liner transport services liner terms are applied meaning that the costs of loading, reloading and unloading and transport are covered by the shipping company (the ship's owner). In the liner system the handling costs or the stevedoring costs are substantial. These are not normally listed in the structure of costs of voyage of ships operating in tramper shipping.

The relation between the supply and demand for the stowage space has no strong or direct impact upon the fare in liner shipping service. The costs of carriage in liner shipping services are not separately contracted for individual carriage, but are structured and listed in the form of tariffs and applied over a longer period of time with no respect to the type and quantity of freight in question.

The basic costs of carriage in river (liner) shipping industry are accordingly the costs of liner ship voyage "in average use of the available capacities corresponding with the long-term anticipated demand for the stowage space and given profit - the capital costs".[5]

3. THE SYSTEM OF COSTS IN LINER SHIPPING AND THEIR QUANTIFICATION

In the system of costs of the voyage of a ship engaged in liner river navigation, we deal with two characteristic stages: (a) the model of voyage costs to be used in the process of quantifying the costs, referring to the costs of ship's staying in the port, and (b) commercial port standard, expressed with the model:

Q and N_q where

"Q" = the costs of navigation and

"N_q" = harbour commercial standard.

In the process of staying in the ports of loading, reloading and unloading, the ship acts as and has the function of a storage. At this stage, for purposes of cutting down the costs, the goods (i.e. the cargo) are transferred from the ship storage to another specified place in the port. In can be either on open or covered port warehouse, a train car, a container, a barge, a truck, etc. The speed of loading, reloading and unloading activities depends upon a number of factors. The most important among these refer to the ergonomic aspect of labour working conditions, ergonomic suitability of the port and other warehouse areas and the level of provision of the necessary equipment.

The impact of the mentioned factors is reflected in the commercial port quota (L_q). The average commercial port quota and the ship load capacity (K_k) determine the time spent in the ports of loading, reloading and unloading, and voyage time.

We may apply the model[6] $s = \frac{2K_k}{L}$, where "s" represents the number of days the ship spends in harbours, in the process of one liner voyage. The model may be used for establishing the number of days a ship

spends in ports during liner voyage in one direction: outbound or inbound (or homebound) voyage.

The voyage comprises a round voyage and is accordingly evaluated.

This is expressed by the model

$$s = \frac{2K_k}{L_q}$$

For a double voyage we have

$$s = \frac{4K_k}{L_q}$$

The costs can be classified from different viewpoints. In river navigation the division into individual groups and types of costs, size of individual groups or columns is of interest, as compared to overall costs. Apparent is the dependence of individual types of costs upon the level of utilisation of the capacities.

In the system of river navigation costs or the costs of the voyage of a ship engaged in river/tourist transport, we have:

- Total fixed costs
- Total variable costs and
- Total costs.

The sub-types of fixed costs may involve:

- absolute fixed costs
- relative fixed costs
- "idle" costs.

The variable costs in liner shipping are:

- total variable costs
- average variable costs
- total digressive variable costs
- average digressive variable costs
- total proportioned variable costs
- average progressive variable costs and

total costs of voyage.

The fixed costs of voyage refer to those not changing in their total amount with respect to the changed level of utilisation of capacities or the output volume, so that these are not sensitive to the changes in the level of the existing capacities. The fixed costs, being the result of the capacities, shall be reported already at the initial stage of voyage and shall not change (as the total costs do) on any route until the full load capacity is reached (transport provided by the available capacities).

These are not fixed by their nature, but come as a result of the given business policy of the shipping company and relevant decisions passed in the process of planning. These decisions involve:

- decisions to purchase the vessels of longer operation life, which will cause the temporal inception costs
- decisions with respect to transport (voyage), loading, unloading, etc., requiring skilled working teams, mechanized loading equipment, ship storages etc., regardless of the actual level of utilisation at individual stages
- decisions to carry out the plans established in conformance with the company business policy to avoid costs that within a shorter period of time do not depend upon the level of utilisation of the capacities.

Fixed costs are therefore conditioned by:

- anticipated freight volumes
- selected technological methods and aspects of operation, and
- technological methods for carrying out the planned assignments in conjunction with the required equipment. They are not caused by transport output volumes reported within an accounting period.

This is the reason as to why the fixed costs over a shorter period of time show the tendency to stay independent of the changes in transport volumes, supposing that no investments have been made for the expansion of capacities. It can therefore be deduced that unless the total costs are changed, the fixed costs per time unit (output day, as an average fixed cost) shall be inversely proportionate with the volume of the transport output, i.e. they will decrease like the average costs during increased transport while in the opposite case of decreased transport (per unit of transported freight ton), they will increase.

The time periods (the time the ship spends in the port and the time it spends during the voyage), can be differentiated and thus it is necessary to give a graphic presentation for a given time period or phase (Table 1 and Figures 1 and 1/a).

Table 1. The trend of absolute fixed costs

Production Volume	Absolute Fixed Costs (AFT)	Average Absolute Fixed Costs (PAFT)
1,000	100,000	100
2,000	100,000	50
3,000	100,000	33.3
4,000	100,000	25
5,000	100,000	20

In order to establish the changes in costs resulting from the changes in the transport scope or provision of the transport service, we may use the coefficient of reaction, defined with the respective percentage of the effectuated changes in costs and the percentage of the effectuated changes in the amount or volume of the supplied transport service (production).

The coefficient of reaction is expressed with the model:

$$K_r = \frac{\%\Delta T}{\%\Delta Q}$$

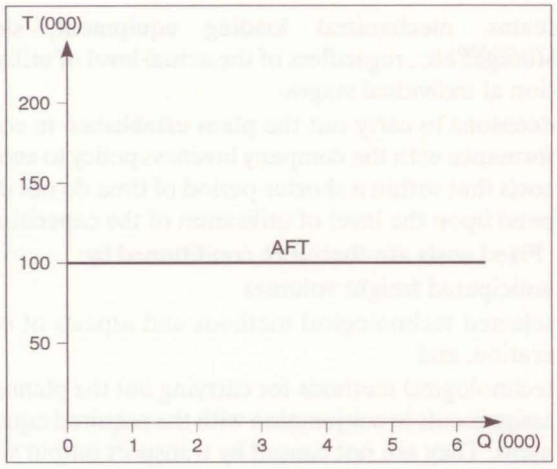

Figure 1

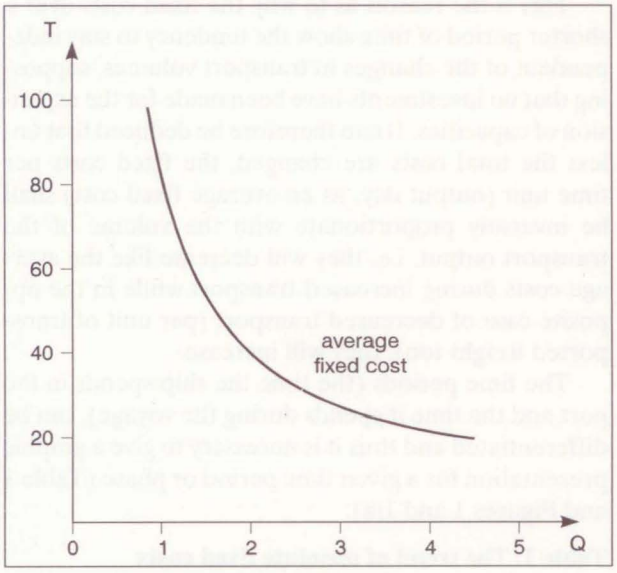

Figure 1/a

where

$\%\Delta T$ – change of total costs

$\%\Delta Q$ – change in the volume of supplied transport service (production).

The major types of costs of a fixed character are:

- contract payments for the lease of the ship, facilities and equipment
- payments of interest rates for debts
- overhead payments of personnel
- depreciation
- regular taxes and membership dues
- (marine insurance) insurance of the ship and other risks
- salaries of managerial personnel and of process organisers
- part of port charges (depending upon the extent of time the ship spends in port, related to commercial operations).

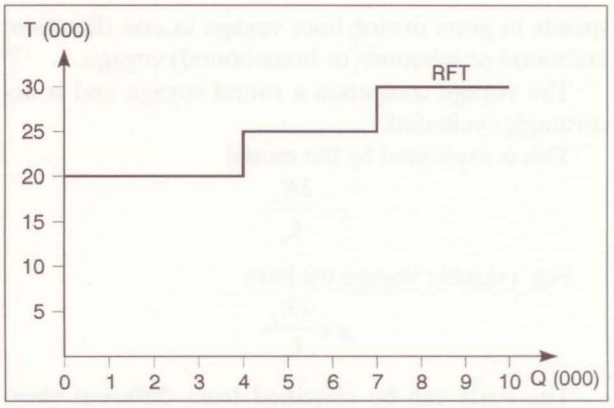

Figure 2

The above classification shows that the inception of fixed costs depends upon the (past) time period in which the existing costs were incurred.

To mark this temporal aspect, the terms "period costs", "time costs", etc., are used in the economic literature.

Absolute fixed costs come as a result of instituting a transport company, and they are often called "hardware costs" or situation costs. These do not depend upon the level of utilisation of capacities. As different from these, the average fixed costs (of the costs per unit of output) constantly change with the changes in production or transport.

As a rule they decrease if the transport increases, i.e. increase if the quantities of transported goods are on the decrease.

The average absolute fixed cost is obtained by dividing the total cost by the number of pieces or using the model:

$$PT = \frac{UT}{Q}$$

Relative fixed costs are those remaining unchanged within the given limits of freight transport scope or zones of operation. When passing from one zone into another, they report abrupt increase (Table 2, Figure 3). Afterwards, they remain unchanged

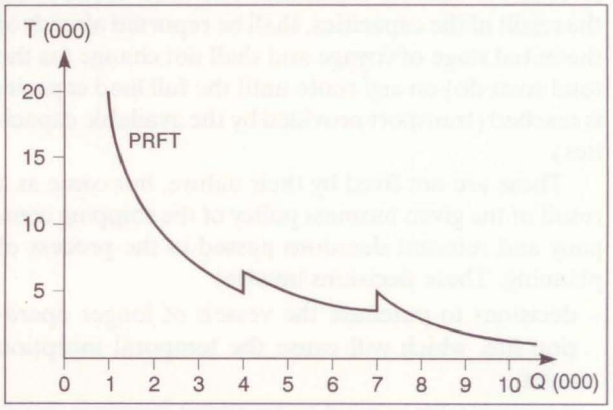

Figure 3 - The trend of relative fixed costs

again until entering other transport zones, i.e. new expansion of the ship capacities or other navigation means capacities.

Table 2. The trend of relative fixed costs

Transport Volume Q (Supplied Services)	Relative Fixed Costs (RFT)	Average Relative Fixed Costs (PRFT)
1,000	20,000	20
2,000	20,000	10
3,000	20,000	6.57
4,000	20,000	5
4,000	25,000	6.25
5,000	25,000	5
6,000	25,000	4.17
7,000	25,000	3.57
7,000	27,000	3.86
8,000	27,000	3.38
9,000	27,000	3
10,000	27,000	2.7

To these costs we most frequently add:
- material costs
- the costs of salaries of the lower and middle level managerial personnel
- the costs of services of technical inspection of the ship and other means

When analysing the absolute fixed and relative fixed costs, it is necessary to explain the term "reaction of costs".

Earlier we have stated that the relative fixed costs show the tendency of preserving the character of absolute fixed costs upon entering a new zone of operation (transport). In short, the relative fixed costs shift into absolute fixed costs, and this occurrence is called reaction.

In the process of recognising and structuring the cost models in river shipping, it is necessary to commit the costs to analysis with respect to their proportion, their existence or duration period and the length of the navigation route, speed of the ship during voyage and the speed of freight handling in the ports of loading, unloading and possible reloading or transshipment. Being familiar with these specific features contributes to the solution of the issues of the business (navigation) policy of liner shipping.

The fixed costs increase with the age (years of service) of the vessel. Each new class of vessels calls for new and higher expenses as well as for longer periods spent in the port (overhaul or repair).

The accepted practice of some shipping companies refers to the (incorrect) investment maintenance of vessels. They do not take as their point of departure the individual ship preliminary calculation, instead, the investment maintenance is calculated and followed up on the basis of the estimate of the respective class or even the entire fleet. The calculated rate is then applied to individual ships (usually the percentage value of the purchase value of the vessels).

This estimate yields the calculative amount of investment maintenance costs per ship and voyage.

Since the purchase value of vessels is considerably higher than that of the older ones, the existing method of estimate of the calculative amount (value) certainly gives a somewhat distorted picture of the maintenance costs of the ship and other *navigation means,* as required in the case of the older fleet.

The port charges include: (a) the costs of towage, (b) the costs of pilotage, (c) the costs of mooring and unmooring, and (d) the costs of different port charges and dues, etc.

Since the fixed costs do not change with the level of utilisation of the capacities (or, their proportion does not depend upon the higher or lower transport capacity of a ship), the question arises as to whether their proportion depends upon something after all. This issue is raised knowing that the proportion of depreciation of the ship is for a half-year statement of accounts lesser than the annual amount and by six times higher than the monthly ship depreciation amount.

3.1. Variable navigation costs and their quantifying

The liner river shipping reports variable costs, because of the fact that there are no companies reporting only fixed costs; instead, these appear in combination with the variable ones. It is therefore said that the overall costs of a transport or of a similar company include both fixed and variable costs (UT = FT + VT). Sometimes these are referred to as direct costs or prime costs.

In the English economic literature these are called variable general costs, defining the costs that in certain terms, not completely though, change with the volume of transport. The longer the navigation route, the more pronounced are the variable costs. When the vessel is anchored, there are no variable costs. The total costs are then equal to the fixed ones.

The variable costs of the ship involve:
- the costs of loading, unloading and possible reloading of the ship
- the costs of fuel and lubricants
- agent costs, agent fees
- different agent's services, if contracted in specific correlation with the fare (or cost of carriage) or the quantity of loaded, reloaded and unloaded freight
- portion of port charges (depending upon the extent of time spent in the port)

- the costs of services by other parties and functional depreciation
- the costs of the subject of work, etc.

The variable costs increase with the increased level of employment (i.e. engagement) and decrease with decreased operations. The variable costs will vary with the level of transport, but these changes of fluctuations are not uniform, because sometimes they rise more slowly than the level of transport, while in some cases they grow at an equal rate with it, or more quickly. Consequently, when the ship is not sailing, being anchored, there exist no variable costs and the total costs are equal to the fixed costs ($UT = FT$).

The variable costs are divided into:

- proportioned variable costs
- degressive variable costs and
- progressive variable costs.

They are expressed with the model:

$$VT_b = PT_b + DT_b + PGT_b$$

$$vt_b = pt_b + dt_b + pgt_b$$

where

VT_b – variable ship costs
PT_b – proportioned ship costs
DT_b – degressive ship costs
PGT_b – progressive ship costs
vt_b – average ship costs

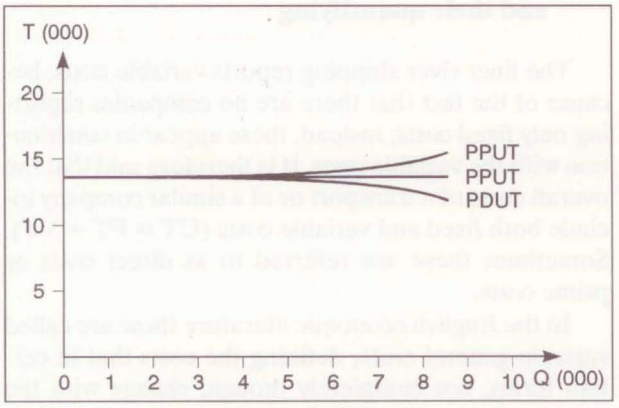

Figure 4 - Variable costs

The crucial impact upon the nature of variable costs is exhibited by the rate of increase of degressive variable and progressive variable costs.

In the system of costs, the fixed costs are the most degressive, "however, at a high level of utilisation of the ship capacities"[7], the degression of the fixed costs, although present, is rather weak. The variable costs do not increase in proportion with the size of the ship; instead, this increase is of a degressive nature. The bigger the capacity, the lesser the degression.

The proportioned costs are those changing commensurately with the scope of carriage, while their coefficient of reaction is 1.

On one side, their features are contiguous with the features of fixed costs, because in individual zones they are fixed, while on the other, they are contiguous with the features of proportioned costs i.e. change in a commensurate manner with the change in the scope of transport.

A high share of proportioned costs in total costs is related to the subjects of transport being characterised by a low organic structure of elements. In modern transport systems the share of these costs is increasingly reducing, because more consideration is given to a more adequate utilisation of the capacities than to the economy of material. The average proportioned

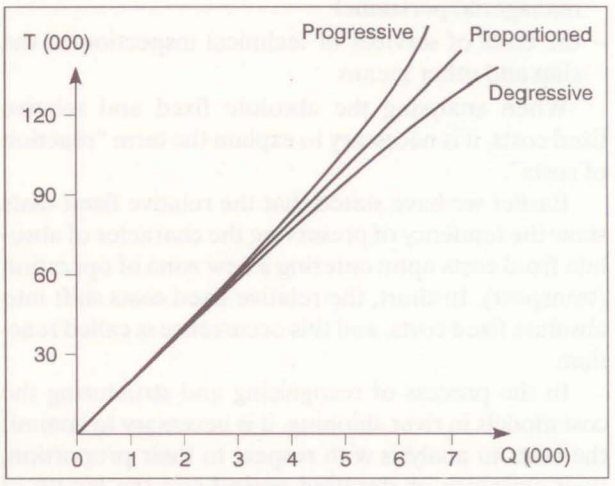

Figure 5 - Progressive, proportioned and degressive costs

Table 3. The trend of variable costs

Production volume - - Supplied Transport Services	Total Variable Costs			Average Variable Costs		
	Prop.	Deg.	Prop.	Prop.	Deg.	Prop
1,000	15,000	15,000	15,000	15	15	15
2,000	30,000	2,900	30,200	15	14.9	15.1
3,000	45,000	44,400	45,600	15	14.8	15.2
4,000	60,000	58,800	61,700	15	14.7	15.3
5,000	75,000	73,000	77,000	15	14.6	15.4
6,000	90,000	87,000	93,000	15	14.5	15.5
7,000	100,000	100,000	100,000	15	14.4	15.5

costs are constant at all levels of transport, while the proportionality as a steady phenomen is mainly theoretical.

The pattern of variable costs is shown in Table 3 and Figures 5 and 6.

The degressive variable costs are those increasing more slowly than the increase in the scope of transport. With the increase of the transport scope, the impact of the degressive costs decreases, and reversely, their impact increases with the decrease of the transport scope. Degression as a phenomenon refers characteristically to fixed costs. The greater the scope of transport, the lesser the fixed average cost. Proportioned costs are commensurate with the level of utilisation of the capacities. However, the dynamic of degressive costs shows that they fall in between the fixed and proportioned costs. This is further confirmed by the coefficient of reaction $0<K_r<1$. When it is closer to zero, then the fixed component is more pronounced, while if closer to one, the proportional component is stronger. The property of progressive variable costs rests upon the fact that they increase similarly with the increased level of utilisation of ship capacities, yet at a quicker rate than the increase in production.

The progression of costs in river transport or generally in a transport system is caused by the so called bottlenecks in the process of operation as well as other disproportions (for instance, the cargo is in the warehouse ready for loading, the freight and labour are available, yet there is no assignment given, or a specified route or destination. Or, the properties of freight and equipment and the qualifications of the man power do not correspond adequately. These are either too high or insufficient.) A typical example of progressive costs refers to the introduction of night overtime, special and extra liner services, resulting in the increased transport output, affecting the variable costs both in an absolute and relative way.

Respective increase in the level of engagement of the ship causes a decrease in the meaning of fixed costs, while that of the variable costs increases in a relative sense. This regularity or pattern is known in the theory of costs as the Law of mass production or mass transport service, as established in 1910 by the German economist Karl Bucher. [8]

$$K = \frac{c}{m_t} + V$$

where:

K – average total costs
C – fixed gross costs
m_t – quantities of transported freight tons
V – variable costs

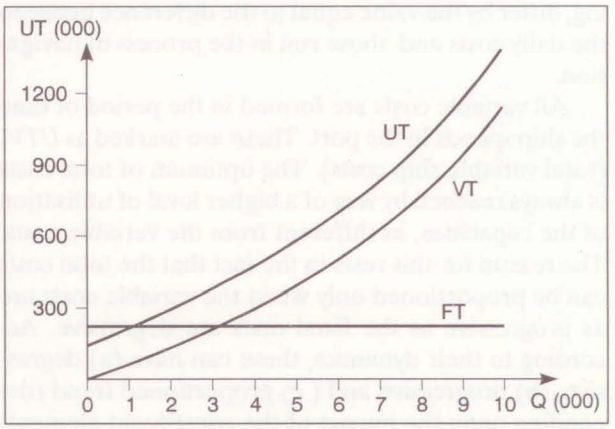

Figure 6 - Total, variable and fixed costs

Table 4. The trend of total and total average costs of service operation

Level of Eployment	Output Volume	Total costs in 000			Average Costs		
0	0	FT	VT	UT	PFT	PUT	PUT
1	2	3	4	5	6	7	8
0	0	200	-	200	-	-	-
10	1,000	200	100	300	200	100	100
20	2,000	200	192	392	100	96	196.7
30	3,000	200	279	479	66.7	93	159.6
40	4,000	200	360	560	60	90	140
50	5,000	200	450	650	40	90	130
60	6,000	200	552	752	33.3	92	125.3
70	7,000	200	665	865	28.6	95	123.5
80	8,000	200	800	1,000	25	100	125
90	9,000	200	945	1,145	22.2	105	127.2
100	10,000	200	1,000	1,300	20	110	130

3.2. Total and average total costs of operation in the river transport system

The total costs of operation of a service comprise fixed and variable costs ($UT = TF + VT$). The total average costs include the sums of average fixed and average variable costs ($PUT = PFT + PVT$).

It has already been said that the period the ship spends in the ports involves different work activities, as e.g. loading of freight into the ship holds, reloading and unloading from the holds.

The basic function of the ship in port is to serve as a freight storage, while the process in question refers to stowage and retrieval of freight.

The costs run in this period are variable and fixed. If expressed in time unit (usually a day) we deal with fixed daily costs.

The basic fixed costs of a ship operating a liner service and those run when the ship is idle i.e. not sailing, differ by the value equal to the difference between the daily costs and those run in the process of navigation.

All variable costs are formed in the period of time the ship spends in the port. These are marked as UTV_b (total variable ship costs). The optimum of total costs is always reached by way of a higher level of utilisation of the capacities, as different from the variable costs. The reason for this rests in the fact that the total costs can be proportioned only when the variable costs are as progressive as the fixed ones are degressive. According to their dynamics, these can have (a) degressive, (b) progressive and (c) proportioned trend (depending upon the impact of the constituent elements and different levels of utilisation of the capacities.)

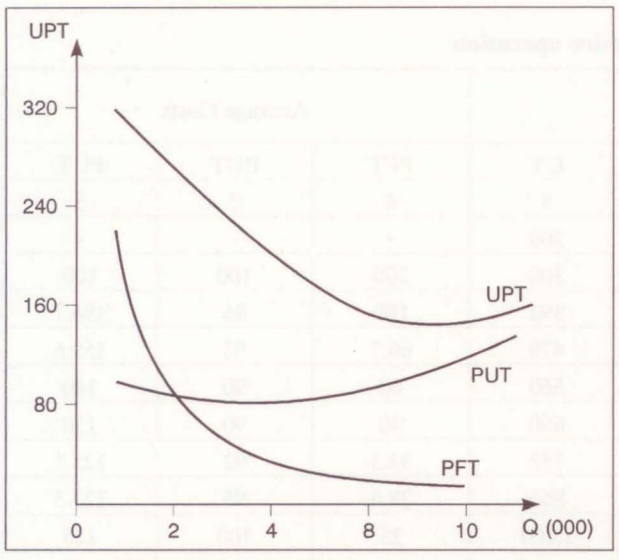

Figure 7 - Total average, average total and average fixed costs

The table and graphic presentation furnish data for the following statements:

- the total costs of the operation of a service (or navigation) increase with the increase of the route mileage i.e. the level of utilisation, as a result of the increase of total variable costs
- average total costs of navigation decrease at the very beginning in a rather intense manner, and then follows a slower decrease caused by the proportioned aspect of variable costs
- for the amount of the transport output of 4,000 and 5,000 we notice that the average total costs are on the decrease at the same rate as the average fixed ones, while the variable costs are proportioned and have no effect upon the total costs
- at a given moment, or at the transport output of 7,000 the average costs reach their maximum, as a result of levelling between the degression of the fixed costs and the progression of the variable costs
- at the level of utilisation of the capacities of 80%, the average costs increase since the progression of the variable ones is higher than the degression of the fixed ones.

The point of costs coverage or the limit of profitability refers to the situation in which the transport company reports no losses or gains. It is calculated by taking into consideration the quantity of transported freight (output) for which the total income covers the total costs.

The volume of required transport outputs generating this point of coverage of costs, is obtained mathematically by the equation UP = UT yielding this coverage:

$$UP = UT$$
$$pc.\ Q = FT + VT$$
$$pc.\ Q = FT + PUT\ .\ Q$$
$$pc.\ Q = PUT\ .\ Q = FT$$
$$Q\ (pc - PUT) = FT$$
$$Q = \frac{FT}{pc - PUT}$$

where:

pc – selling price

(other symbols have already been defined).

The curve of the total costs over a longer period of operation of provision of services begins at starting point, since there are no fixed costs over the long period. The curve of the average costs over the long term is also made on the basis of the short-term average costs.

The curve of the long-term average costs of operation (navigation) is generated by joining the peaks of individual curves of short-term average costs of operation (navigation). Figure 10 shows that the curve of the long-term total costs (KUTUDR) does not neces-

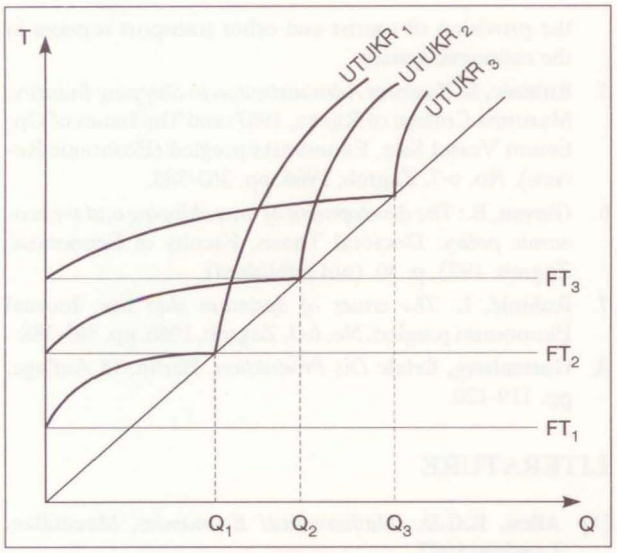

Figure 8 - The curve of the long-term total costs

sarily have to decline in all points. It often has the form of the letter U and is always less acute than the curves of the long-term total average costs of navigation (KPTUKR).

The declining (valley) segment of the curve of the long term average costs accounts for the economy for the transport scope. At this stage, increased transport or yield is reported with respect to the proportions. The peak or crown portion of scope, with a decreased yield with respect to the proportions.

For the sake of explanation, longer term refers to a time period in which all the elements of transport and other services are variable. If there are no fixed elements there are no fixed costs.

Over that period the changes may be effectuated in the quantitiy and the quality of transport elements.

Transport enterpreneurs may liquidate their company and establish a new one in some other transport industry or business.

In short, short-term involves the term of fixed production of a transport service or some other aspect of production, while long-term involves the temporal aspect of the variable transport service.

4. CONCLUSION

Transport on inland navigation routes falls into the category of the so called traditional transport industries and segments of the economy and tourist trade, playing a major role in society.

From the aspect of long distance mass transport, its advantages may be evaluated from the energy, economy (industry and tourism) utilisation related viewpoints. It has been estimated that by using one liter of fuel, one ton of freight can be transported over

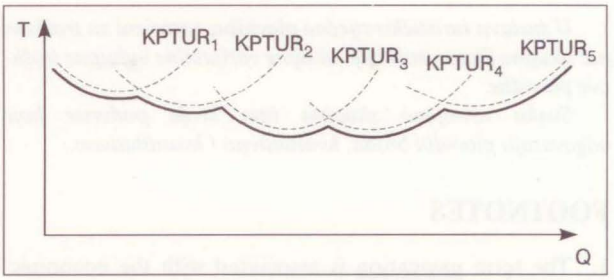

Figure 9 - The curve of the long-term average costs

127 km by oil pipeline, 106 km by river, 84 km by rail, 25 km by road and 1.6 km by air.

Considering its transport capacities, river transport is way ahead of other transport industry segments. In order to transport 5,000 tons of freight by railway, it is necessary to use a 500 car train, or 250 trucks for carriage by road (on the routes more than 30 km long), while the same volume of freight is transported in the river liner shipping system by barges in convoy.

The fixed costs have a share in the total costs (Ut_{pr}) of the carriage of one ton of freight of 61% in rail transport, of 50% in road transport and of 10% in river transport on the average.

Despite its obvious advantages, the river liner shipping and tourist traffic exhibit some deficiencies, to be ascribed primarily to its high dependence upon weather conditions (low/high water level, icing of waterways), limitations of the unit capacities of the vessel by the most disadvantageous clearances, liners are slower than other modes of transport, etc., and in the final run it is assigned (in the example of the countries with advanced transport systems) the position in the system that belongs to it viewed realistically.

The basic costs of transport in river/tourist (liner) transport are the costs of the liner voyage, with the average utilisation of the capacities corresponding to the long-term anticipated demand for the ship space and given profit - costs of the capital.

SAŽETAK

KVANTIFIKACIJA TROŠKOVA U RIJEČNOM PROMETNOM SUSTAVU

Kvantifikacija i vrste troškova u riječno-turističkom prometu odnose se s različitih motrišta.

U riječnom brodarstvu, interesantna je podjela na pojedine grupe ili vrste, glede odnosa prema ukupnim troškovima.

Uočljiva je ovisnost pojedinih vrsta troškova o stupnju iskorištenja kapaciteta broda (u turističkom putovanju).

Osnovni troškovi prijevoza u riječnom (linijskom) brodarstvu jesu, dakle, troškovi linijskog putovanja broda, uz prosječno korištenje kapaciteta koji odgovaraju dugoročnoj predviđenoj potražnji brodskog prostora i određenom profitu, kao i troškovima kapitala.

U sustavu turističko-riječne plovidbe, ustrojeni su troškovi na: ukupne fiksne troškove, ukupne varijabilne i ukupne troškove plovidbe.

Svaka ustrojena skupina ima svoje podvrste koje odgovaraju plovidbi broda, kvalitativno i kvantitativno.

FOOTNOTES

1. The term navigation is associated with the economic-tourist industry. In foreign literature (Italian: navigazione di linea, navigazione libera, French: navigation de ligne etc.) The terms "Liner shipping and tramp shipping" are used in English. In its basic meaning the term "navigation" refers to the process of navigation-sailing and so it is not recommendable to apply other attributes.
2. The word "capacity" comes from the Latin verb "capare": grasp, comprehend, subsequently giving the Latin noun "capacitas": ability to hold. This refers to the ability or capacity of a transport company, a machine or a vehicle to carry or produce a given transport output over a specified period of time under full load.
3. Cost(s): in the most limited sense involves conscious consumption (drastic use) of useful items in the process of production, with the objective of getting in return some useful products, services or other effects. Accordingly, consumption in the process of production (of transport services) does not involve irrecoverable or final structuring of production factors, but reproduction oriented use in order to make a new product or produce a new service. The definition thus covers the worth of used products or elements of production (in money equivalent), related to the structure of the purchase price or the selling price of a product (or service).
4. Liner shipping involves the operation of a continuous freight service on the established navigation routes and the provision of tourist and other transport services in the economic system.
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