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Valery Kysly
Ph.D in Economics,
doctorate student of National Aviation University

THE ABSTRACT- PROPORTIONAL AVERAGE TRANSPORT SPEED OF DELIVERY AS THE FACTOR ANALYSIS OBJECT FOR THE VOLUMES OF BRANCH PRODUCTION

Methodical approaches to calculation of the abstract-proportional transport speed indicator are offered; the expediency of its introduction to the practical analysis for the state of industrial-economic systems is proved.

Keywords: cargo turnover, average distance of transportation, speed of delivery, working hours fund, a number of trips.

Statement of the problem. Conducted on the basis of physics-technology analysis of the transport product parameters [1] reveals secondary (mediated by the speed of delivery) role in forming its average distance rate. Despite of the straight-proportional relationship between distance and turnover the variance of the first factor can not be a result neither of enterprise-carrier activity nor of external factors of market development influence, it just reflects only the technological peculiarities and the geographical features of the transport system. Meanwhile, traffic speed as the quantitative parameter [2] of the transport production is capable to display the intense of changing the carrier efforts with additional time resource involving [1]. Time save as well as its wasting for moving cargo and passengers creates the prerequisite for appropriate general variations of turnover volumes.

Thus, for factor analysis of transport product dynamics the replacement of the medium-distance range with the correlated average velocity parameter lets us identify instead of resulting market consumption value directly its equivalent of intra-corporate provision. This transformation essentially despite of its mathematical non-importance also is able to reveal the principal causal factor relationship.

Analysis of research and publications. This article is a continuation of the author's papers [1, 2] in elaboration of ideas dedicated to quantitative incorporating the speed component in the high-speed transport production.

As an alternative to the existing developments in the economy of transport aimed at taking into account the quantitative value of vehicle speed in branch product [3 - 7] the statement of author’s own vision of this problem and the related solving methodology are proposed.

The purpose of the publication is working out the essentially adequate macroeconomic analysis parameters which are capable to guarantee full use of opportunities in respect of factor analysis techniques concerning passengers and cargo turnover as key indicators of transport action.

The main material. The average distance of transportation both for a particular transport mode and for a country or for a region transport system, based on cargo turnover and on weight of transported goods (passengers turnover or number of passengers respectively) can be represented as a kind of abstract multiplier which increased the second index allows to define the first one:

$$\sum pl = \sum p \cdot l_{сер} \ , \qquad (1)$$

with Σpl – cargo turnover, t-kilometers; Σp – weight of transported cargo, tons; $l_{сер}$ – the average distance of transportation, km.

The inverse form:

$$l_{сер} = \frac{\sum pl}{\sum p} . \qquad (2)$$

From a physical point of view the same indicator of medium-range distance can be expressed by the average speed of cargo delivery and spent time on it:

$$l_{сер} = \upsilon_{сер} \cdot t_{сер} \ , \qquad (3)$$

with $\upsilon_{сер}$ – the average speed of delivery, km/h; $t_{сер}$ – the average technology time for one delivery, h; which may be calculated:

$$t_{сер} = \frac{T - T_{прост}}{n_{сер}} \ , \qquad (4)$$

with T – calendar fund of working time per vehicle during the reporting period, h; $T_{прост}$ – average idle time out of commercial traffic for one vehicle during the reporting period, h; $n_{сер}$ – the average number of trips per a vehicle during the reporting period.

Thus, expressed by all previous equations the cargo turnover is associated with the speed as follows:

$$\sum pl = \sum p \cdot \upsilon_{сер} \times \frac{T - T_{прост}}{n_{сер}} . \qquad (5)$$

Given that the length of downtime is a part of the general running time fund through the expression of this index by a relative measure $k_{прост}$ – the coefficient of corresponding share of the average idle time out of commercial traffic for one vehicle during the reporting period in its calendar fund means:

$$k_{прост} = \frac{T_{прост}}{T} \ , \qquad (6)$$

so the equation (5) takes the form:

$$\sum pl = \sum p \cdot \upsilon_{сер} \times \frac{(1 - k_{прост})}{n_{сер}} \times T . \qquad (7)$$

Comparing the formulas (1) and (7) we note for the last one the occurrence of additional to (1) and fundamentally-important to determine the cargo turnover the measures in a “pure form”: share of idle time $k_{прост}$ and the number of trips $n_{сер}$. Clearly, these figures also directly contribute to the sheer weight of cargo transportation Σp that is an equal component of Σpl in formulas (1), (7). However their factor performance is available in the form of a complex with a number of other parameters. For instance,

$$\sum p = n_{сер} \cdot N \cdot p_{сер}\,, \tag{8}$$

with N – the total fleet of vehicles, units; $p_{сер}$ – average load of one vehicle, t; from (4) and (6):

$$n_{сер} = \frac{T \cdot (1 - k_{прост})}{t_{сер}}, \tag{9}$$

and therefore, combining formulas (8) and (9), we get:

$$\sum p = N \cdot p_{сер} \cdot T \times \frac{1 - k_{прост}}{t_{сер}}\,. \tag{10}$$

In the case of formula (7) a time out of transportation process proportion as well as the number of trips are totally singled components. This fact makes the average speed of delivery $\upsilon_{сер}$ as an alternative to medium-range distance $l_{сер}$ (equation (3)) exceptionally interesting indicator for reasons of finding opportunities to separate the factors of forming the transport product by exogenous and endogenous nature of origin.

It is recognized that the general volume of transport production which is a turnover and delivered tons of cargo figures proportionally depends directly on the level of overall economic development. Thus, for example there is well-known phenomenon of two-three percent growth in air travel in the country due to one-percent increase in its gross domestic product [8 - 10]. Consequently, there is an objective relation between changes in the quantity for branch productivity and the market sector (exogenous) development.

The number of trips parameter $n_{сер}$ is associated right with that changes, as dependence expressed by the formula (8) exists, it is the only one which directly determines the resulting value of carried by the transportation system tones of cargo. The other two components: both the volume fleet of vehicles and their load capacity, have the second-mediated dependence; they also are determined by external market parameters, the general needs of economy, but require adequate forming their own certain time lag associated with the production capacity of carriers to respond quickly to the changing needs of exogenous origin.

However, the value of the average number of trips for the time period in (7) is integrated into a complex component $\left[\frac{1 - k_{прост}}{\mathrm{n}_{\mathrm{сер}}}\right]$. Available in it index $k_{прост}$ through the ratio $\left[\frac{t_{сер}}{\mathrm{T}}\right]$ also is determined by the size of $n_{сер}$ (see expression (9)). That fact allows in mentioned complex component the partial compensation for number of trips changes factor with the equally directed change of average share of idle time per one vehicle. The extent of such compensation would depend on the measure of t_{cep} and T ratio because of (9),

$$k_{прост} = 1 - n_{cep} \times \frac{t_{cep}}{T} . \quad (11)$$

That part of the average number of trips, which remains outside the compensating influence of the idle time coefficient can be treated as intra-significant and qualified as not related to changes in traffic volumes directly. Conditional example shown in Fig. 1 demonstrates the way in which the number of trips regardless of turnover and the weight of transported goods can cause the organizational efforts of freight carrier, while not having any relation to the intensity of use in time for fleet. At the same time, a large amount of trips number requires more administrative efforts associated with transport production scale, which of course can interpret the nature of n_{cep} in the intensive variant of changes as completely internal. That value of index variation which is associated with increased total idle time of transport fleet (formula (6)), because of particularity of its action (formula (9)) can be seen as motivated by extensive shifts of external origin in a short time period.

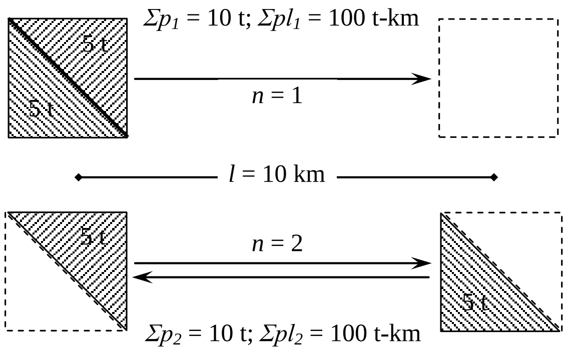

Figure 1 – Demonstration of the hypothetical mutual independence between traffic volumes and the number of vehicle trips

Similarly υ_{cep} factor is the product of the internal transport process organization being undoubtedly the result of individual management activities of carriers or infrastructure sector enterprises which provide a process in motion.

Thus, according to the proposed interpretations replacement of equation (1) by the same but more content of charge-rich equation (7) in analytic calculations provides a significant advantage which is expressed in expanding the boundaries of perception for the factor influences to the performances of transport sector. If interpretation for the measure l_{cep} (the first case) allows just to state the established capabilities of transport market due to external demands of clients, the introduction of υ_{cep} states the conditional but quite clear boundaries for both exo- and endogenous factors of forming the cargo turnover. (All presented calculations are similar and related to the estimation of passenger traffic: passenger turnover and number of transported passengers.)

With that formula (1) in its right part has purely exogenous load its alternative interpretation has three distinct components. The first of them is conjectural dependent Σ*p*; second one is caused by transport production efforts $\left[\upsilon_{cep} \times \frac{1-k_{npocm}}{\mathrm{n_{cep}}}\right]$; the third is the objectively fixed time scale *T*.

Analysis of the first indicator variation enables to detect structural changes in Σ*pl* caused directly by transport market; review of the last one potentially lets to estimate correlations among the transport production results performed in different by duration periods: it can be done in reasons for making interpolation for turnover amounts in small time intervals and extrapolation for the same data, respectively – in longer ones.

Present in quadratic brackets complex component characterizes the value of the manufacturing contribution of the sector, performed with the additional in comparison with the previous time using its own organizational reserves (in case of increase), or their under-utilization (decreasing, respectively). Therefore, it should be noted again that Σ*p* and *T* assess the scale of extensive growth, then $\left[\upsilon_{cep} \times \frac{1-k_{npocm}}{\mathrm{n_{cep}}}\right]$ – intensive one.

Concentrating on the practical application aspects for this complex measure which as the one that has the dimension [km/h] logically could get called "*average specific transport speed*", in our opinion reveals series difficulties for their complete lack for other two. Thus, the numerical assessment of all three constituent variables: average speed of rolling stock, its idle time ratio and average number of trips will certainly be some difficulties not only at the sectoral macro level. At the micro level of an individual carrier would be needed not only methodologically complicated calculations, but also introduction of special statistical reports for individual transport modes required for collecting the objective source data.

Given the above it is considered as completely reasonable to calculate particular measure by the method of mathematical exclusion, that is by available initial values Σ*p* and *T* as well as resulting Σ*pl*.

At the same time qualitative interpretation of the quantitative value of the average specific transport speed can present a number of difficulties in the context of comparability for different carriers, conditions and means of their transport systems. The reason for this is in a complex combination of elementary components embedded into indicator.

First, within the overall macro level system average speed υ_{cep} is determined mostly by significant variation caused by gravitational peculiarities of production processes of a carrier assigned to a fundamentally different modes of transportation: water, land and air [1]. In this regard there is a natural problem of comparability for their representatives.

Second, regarding the specific transport comparability of average specific transport speed for different transport operators, defined values of $\mathrm{k_{прост}}$ and n_{cep} will probably result in significant differences of indicator for heavy- and light-duty vehicles, shipping the packaged or the general cargo, homogeneous and multimodal transportations, etc.

Third, in our opinion the most serious problem is quite complicated for the professional perception overall physical content of the proposed index. Indeed, dividing the average speed achieved during the transportation into the number of trips has entirely abstract value resulted.

As the most appropriate way to solve the problem seems the introduction of a similar but modified parameter "*abstract-proportional transport speed*". It is derived from the previous analogue and defined by its multiplying by conventionally taken, convenient for further calculations in terms of application of obtained results number of trips during the analyzed period. For example, this number may be 100, 1 000, 10 000 travels a month, quarter, year, etc. We believe that a desired condition is to respect the equality of a number of trips estimated for all the analyzed sustainable transport systems regardless of the mode, type of cargo, the nature of transportation and others.

Thus, abstract-proportional transport speed is to be determined in the manner:

$$\upsilon_{сер}^{ум} = \left(\upsilon_{сер} \times \frac{1 - k_{прост}}{n_{сер}} \right) \times n_{ум}, \quad (12)$$

with $n_{ум}$ – notional number of trips during the analyzed period.

The dimension of obtained measure and therefore its content for now, in our opinion, can not be in dispute (see (12)):

$$\upsilon_{сер}^{ум} = \left[\frac{km/h}{trips\ number} \times trips\ number = km/h \right]. \quad (13)$$

The same approach can be used for the second of mentioned problems. That is, assuming the complexity of $n_{сер}$ is eliminated, to apply conventional value for $k_{прост}$, for example, equal to 0. That means the conventional absence of time losses for the transport system of unproductive vehicle use during its maintenance periods, of waiting for the technological operations, of reservation and so on.

For solving the first problem seems to be quite sufficient to establish calculations of partial indexes of abstract-proportional transport speed separated by each transport mode, thus limiting the effects of heterogeneity for fundamentally important factors by the frames of relatively stable conditions of production activities. Meanwhile of potential importance becomes not the absolute value of $\upsilon_{сер}^{ум}$ but its relative temporal change. Thus, methodologically we obtain the index suitable for the dynamic analysis of the size of the production efforts made by carriers within separated modes.

Thus, the final formula for the analytical calculation of abstract-proportional transport speed for the transport system that clearly expresses its physical meaning is:

$$\upsilon_{сер}^{ум} = \frac{\sum pl}{\sum p} \div T \cdot n_{ум}. \quad (14)$$

Application of the formula is considered to be appropriate in complex calculations when determining the change of abstract-proportional speed of a transport system. A positive value of it provides the quantitative expression to positive organizational and economic changes concerning achievements in obtaining the sectoral production results, respectively negative value gives the negative characteristic to the situation.

According to the equation (7) the index of abstract-proportional transport speed is of direct multiplicative factor features, therefore it can result in a proportional change in effective value of cargo turnover. Its monitoring is extremely important for reasons of tracking actual current trends in any transport system of arbitrary level: from the lowest microeconomic up to the highest international one.

Conclusions. Calculations above are the basement explanation for rationality of the new economy category introduction – rate of abstract-proportional transport speed. Analysis of its essential content and performed formalization of calculating allow to motivate introduction into economic practice and management letting adequately assess the real changes in individual economic units of a transport sector.

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Кислий В. М.

УМОВНО-ПРОПОРЦІЙНА СЕРЕДНЯ ТРАНСПОРТНА ШВИДКІСТЬ ДОСТАВЛЕННЯ ЯК ОБ'ЄКТ ФАКТОРНОГО АНАЛІЗУ ОБСЯГІВ ГАЛУЗЕВОГО ВИРОБНИЦТВА

Запропоновані методичні підходи щодо розрахунку показника «умовно-пропорційна транспортна швидкість»; обґрунтована доцільність його запровадження у практику аналізу стану виробничо-господарських систем.

Ключові слова: вантажообіг, середня дальність перевезень, швидкість доставлення, фонд робочого часу, кількість поїздок.

Кислый В.Н.

УСЛОВНО-ПРОПОРЦЙЩНАЛЬНАЯ СРЕДНЯЯ ТРАНСПОРТНАЯ СКОРОСТЬ ДОСТАВКИ КАК ОБЪЕКТ ФАКТОРНОГО АНАЛИЗА ОБЪЁМОВ ОТРАСЛЕВОГО ПРОИЗВОДСТВА

Предложены методические подходы к расчёту показателя «условно-пропорциональная транспортная скорость»; обоснована целесообразность его внедрения в практику анализа состояния производственно-хозяйственных систем.

Ключевые слова: грузооборот, средняя дальность перевозок, скорость доставки, фонд рабочего времени, количество поездок.

v_kiss@ukr.net