Session 4

Transport and Business Logistics

POTENTIALITIES OF DEAN'S STATIC MODEL IN THE PROCESS OF SYNCHRONOUS INVESTMENT AND FINANCIAL PLANNING IN THE FIELD OF TRANSPORT

Alla Seryogina, Natalya Gode

Transport and Telecommunication Institute
Lomonosova 1, Riga, LV-1019, Latvia
Phone: (+371)-7100615. E-mail: nvgina@tsi.lv

Problems of the complex approach to acceptance of investment and financial decisions are considered in the given article.

The theoretical substantiation of opportunities of the Dean's static model use is resulted during synchronous investment and financial planning on transport, and technique of an estimation of efficiency accepted business decisions is discussed as well.

Keywords: investment object, financial object, synchronous investment and financial planning, optimal investment program

1. INTRODUCTION

The purpose of the given article is the theoretical substantiation of opportunities of the Dean's static model use in transport firms activity at acceptance of investment and financial decisions.

In the theory of finance of the most known the concept of limiting cost of the capital, supposing is at definition of the optimum budget of capital investments comparison of a parameter of limiting profitableness of the capital and a parameter of limiting cost of the capital. The given concept has abstract enough character that complicates opportunities of its practical application. Models synchronous investment and the financial planning, having more formalized character is little known.

Problems of the complex approach to acceptance of investment and financial decisions play an important role in the activity of any enterprise using for realization of capital investments external sources of financing.

2. THEORETICAL ASPECTS OF DEAN`S MODEL

In decision making process regarding the capital investment, it is important to consider the interrelation existing between the financial and investment spheres. Thereby profitability of raising funds depends on investment resources. On the other hand, advantages of the investment alternatives are determined by financial potentialities and related costs. The interrelation mentioned above may be considered in the models of synchronous investment planning and the source of investment funds.

In the theory of investment analyses there are known such models of synchronous investment and financial planning as the multistage model by Hax and Waingartner, the one-stage model by Albach and the static model by Dean. The models listed above differ in their diverse purpose functions and their approach to the factor of time.

Exploitation of the listed models provides the following assumptions:

1) the final number of investment and financial alternatives is known;
2) the situation is defined;
3) only the monetary effect of investment and financial alternatives is essential;
4) each particular investment object is assigned a processing program;
5) the term of exploitation and duration of the investment object financing is stated;
6) the investment object and the source of funds do not exclude each other, and they may be realized independently.

Besides the assumptions mentioned above, Dean's static model of synchronous investment and financial planning provides also the following statements:

- there is only a relevant period, at the beginning and at the end on which all the payments characterizing the investment and financial objects, are settled down;
- the investment and financial objects are realized and divided up to a definite and defined amount.

Certainly, if there are many assumptions, the potentialities of Dean's model exploitation are limited for any investment objects; in particular it is difficult to use this model in the process of planning investments in industrial objects. Therefore in such cases there are models of synchronous investment and industrial planning, for example, a model with several industrial stages by Ferstner-Henn, as well as Jacob's model with the choice of facilities and disinvestments.

However, regarding most of the transport objects (in particular, the objects of motor transport and railway transport), the assumptions listed above are commonly observed.

Namely:

* the final number of investment and financial alternatives are rather certainly known;
* the investment objects and the financial objects – they may be realized independently;
* the objects are rather liquid;
* the term of exploitation is rather clearly determined;
* the investment objects may be divided up to the defined size and then realized.

It means that generally Dean's static model of synchronous investment and financial planning may be applied to the sphere of transport.

Let's consider the main component parts of Dean's model. The model is purposed to the maximization of the final property value of the common investment and funding program. The final value of the property is determined at the end of the considered period as a balance of investment receipts and expenditures. It is considered that at this particular time in the investment objects there are receipts exceeding expenditures. In the beginning of the particular period it is important to provide the financial resources required for investment realization by means of proper measures and efforts in the field of funding.

The mathematical model is formulated in the following way:

The variables:

Xj = the volume of investment object j (j = 1,...,J) realization,

Yi = the volume of funding object i (i = 1,…,I) exploitation.

Parameters:

Ajt = net, income (receipts) from investment object unit j exploitation at the definite time t (t = 0,...1),

Dit = net payment for the funding object unit I at the definite time t (t = 0,...1).

The purpose function (for t = 1)

$$\sum_{j=1}^{J} Aj1 \cdot Xj + \sum_{i=1}^{I} Di1 \cdot Yi \Rightarrow \max, \text{ where}$$

$\sum_{j=1}^{J} Aj1 \cdot Xj$ – Net income of the investment objects;

$\sum_{i=1}^{I} Di1 \cdot Yi$ – Net payments of the financing objects.

The purpose function of the net payment sum, which is the final result of the income from the realized investments and payments regarding the object financing, strive for a maximally positive result.

The provisions of financing in the model of this particular type for t = 0 are as follows:

$$\sum_{j=1}^{J} Aj0 \cdot Xj + \sum_{i=1}^{I} Di0 \cdot Yi = 0, \text{ where}$$

$\sum_{j=1}^{J} Aj0 \cdot Xj$ – Net income of the investment objects;

$\sum_{i=1}^{I} Di0 \cdot Yi$ – Net payments of the financing objects.

The investment objects require financial payments (negative net payments) which are realized by means of income gained from the exploited financial objects. Terms of the project are the following:

$0 \leq Xj \leq 1, \quad \text{for } j = 1, \ldots J$;

$0 \leq Yi \leq 1, \quad \text{for } i = 1, \ldots I$.

Investment objects and financial objects may be realized in any shares of the maximal total volume ($Xj = 1$ and $Yi = 1$).

3. PRACTICAL APPLICATION OPPORTUNITIES OF SYNCHRONOUS INVESTMENT AND FINANCIAL PLANNING IN TRANSPORTATION

The method of choosing the optimal solution may be illustrated by means of the following example.

Let's assume that some transport company *X*, engaged in freight traffic, are making the decision regarding the purchase of five trucks with various load-carrying capacities and different aim significance (let's call them "investment objects"). Since the trucks are of different aim significance, they will differ also in price. The profitability of their exploitation is also essentially different. The expenses on trucks will be covered by inner funds, besides the terms of funding from different sources will differ as well.

The demand on capital funds is characterized by the total amount of all the investment objects; however the total supply of the capital funds depends on the price (an interest rate) of different funding sources.

Table 1. The demand on capital funds for different investment objects and the supply of capital funds for different financial objects

Investment objects	***Aj*0 Euro (thsd.)**	***Aj*1 Euro (thsd.)**	**Object Profitability (%)**	**Priority**	**Cumulative significance of the demand on capital funds**
Object 1	-70,0	77,0	10,0	5	250,0
Object 2	-60,0	69,0	15,0	1	60,0
Object 3	-50,0	56,5	13,0	3	140,0
Object 4	-40,0	44,8	12,0	4	180,0
Object 5	-30,0	34,2	14.0	2	90,0
Financial objects	***Di*0 Euro (thsd.)**	***Di*1 Euro (thsd.)**	**Calculated percents (%)**	**Priority**	**Cumulative significance of the supply of capital funds**
Object 1	20,0	-21,2	6,0	1	20,0
Object 2	40,0	-42,8	7,0	2	60,0
Object 3	50,0	-54,0	8,0	3	110,0
Object 4	70,0	-76,3	9,0	4	180,0
Object 5	70,0	-77,7	11,0	5	250,0

The problem of optimisation looks like as follows:
The purpose function:

$$77X1+69X2+56{,}5X3+44{,}8X4+34{,}2X5-21{,}2Y1-42{,}8Y2-54{,}0Y3-76{,}3Y4-77{,}7Y5 \Rightarrow \max$$

Additional terms of financing

$$-70X1-60X2-50X3-40X4-30X5+20Y1+40Y2+50Y3+70Y4+70Y5 = 0$$

On the basis of the data regarding the profitability of investment objects and the cost of their financing mentioned in the Table1, it is possible to realize the advantages both of the investment objects and of the financial objects. The data on the presented Table 1 also contain information regarding the total demand on capital funds and the supply of the capital funds, depending on the interest rate. Ranging investment objects with the indicators of maximal expenses on the purchase, may be used for determination depending on the rate of common demand on the capital funds.

To reach an optimal program, it is required that the demand on the capital funds is equal to the supply of the capital funds, since, on the one hand the program has to be furnished with finances, however on the other hand, credit in big amounts economically would not be the best solution. Having considered the advantages of investment objects and financial objects, starting with the investment object with the greatest priority, investment objects are gradually included in the investment program up to the time their profitability is higher than the rates of object financing.

The optimal solution of the model may be defined also by graphical means. To do it, one has to depict the function of demand and supply of capital funds on the diagram. The function of capital demand, on the basis of the investment objects offered for choice, shows how much of capital funds are spent at particular rates of profitability; the function of capital fund supply represents the total capital supply depending on the interest rate. At the point of intersection of the curves of capital demand and supply the optimal investment and financial program is developed. Besides, it is possible to determine the value of the interest rate, at the same time representing profitability of investment objects and financial objects (endogenous or marginal interest rate). The curve made according to the conditions of the set example can be seen in the following Figure 1:

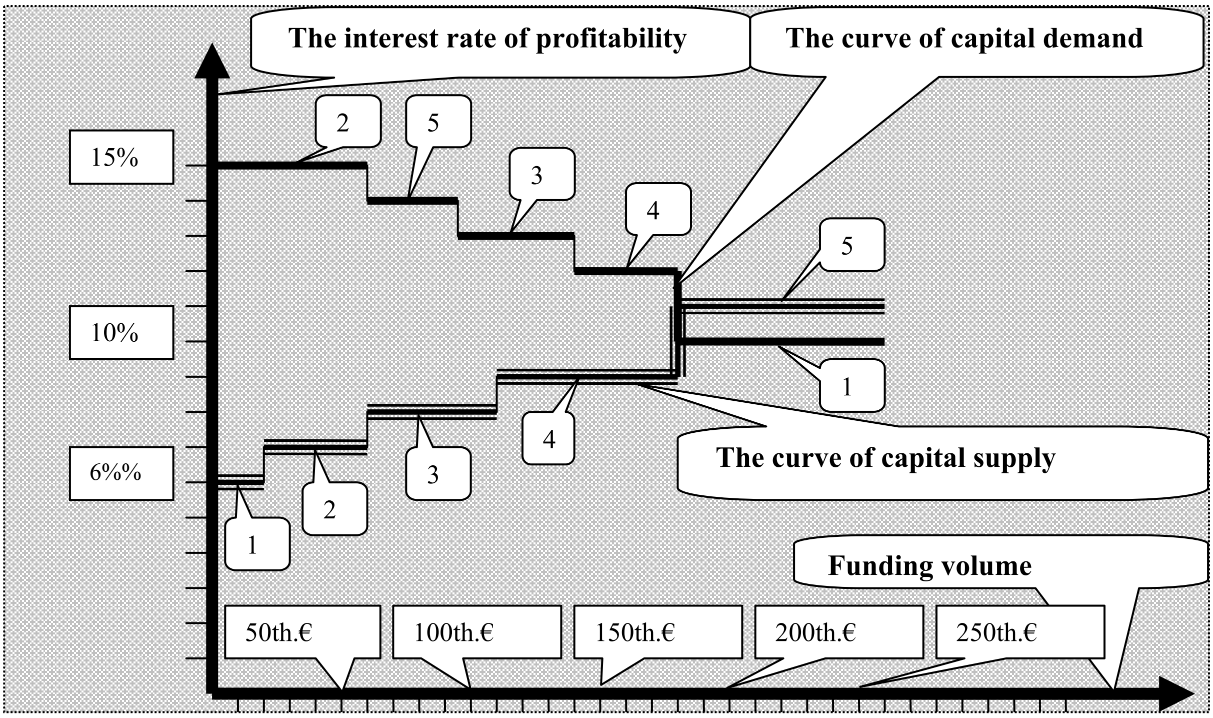

Figure 1. *A graphic ratio of a supply and demand of the capital by optimisation investment and financial programs*

In the graphic we can see the curve of capital demand and the curve of capital supply. The curve of capital demand is the descending one, since the realization of investment projects usually starts with the most profitable and finishes with the least profitable ones. Regarding the level of priority, the first position is held by the second investment object with the profitability of 15%, the second position is held by the fifth object with the profitability of 14%, etc. The total amount of capital demand is 250 thousand Euro. Unlike, the curve of capital supply on the upwards going, since the companies are more eager to use the cheapest sources of funding, and only afterwards they turn to more expensive sources of funding. The optimal investment and financial program corresponds to the point of intersection of the curves of capital demand and capital supply, which is equal to 180 thousand Euro. The first investment object with the amount of 70 thousand Euro cannot be realized, since the resources required to finance it, exceed the level of profitability of the investment object. (When the level of profitability of the investment object is 10%, the price of financing is 11%).

The effect arising from the investment and financial program is determined as the difference between receipts and expenditures at time $t = 1$. In the offered example the effect arising from the investment and financial program is 10, 2 thousand Euro (seen as the difference between the income and investment, composing 24.5 thousand Euro; the interest payment makes up 14.3 thousand Euro.)

In the present example the investment and financing amounts of four objects are the same; therefore it is possible to reproduce graphically the synchronism of investment and financial planning. However in case the investment objects can be divided; sometimes it is not possible to develop an optimal program out of graphical concepts. For example, it is impossible in case the optimal program is defined graphically; however the investment object is included in the program only partly (like in the example with the investment object 5). In this case the optimal program offers exploitation of the method of partial and full intersection. This method provides enumeration of all the possible investment programs. Then for each such program, by means of a previously set sequence, there is attributed a financial program, in such a way its volume is equal to the volume of investment. Then, each of the investment and financial programs mentioned above, may be calculated, the effect is the difference between receipts and expenditures. The program with the maximal total effect, is the most successful and optimal one. This approach may be illustrated by means of the example offered above; the only difference – the first investment object, which is obviously unprofitable, shall be excluded. All the required calculations can be found in the following Table 2:

Table 2. Optimisation of investment and financial programs' volumes

Investment program	**Demand on Capital (thsd.)**	**Financial program**	**The total effect of investment and financial program Euro (thsd.)**
Investment objects 2	50	Financial objects 1,2	5
Investment objects 2,5	90	Financial objects 1,2 and 0,6 Financial object 3	6,8
Investment objects 2,5,3	140	Financial objects 1,2,3 and 0,43 Financial objects 4	9
Investment objects 2,5,3,4	180	Financial objects 1,2,3,4	10,2

In the presented example, the results received by graphical means and the results offered by the method of listing objects, coincide. The amount of an optimal investment and financial program is 180 thousand Euro. In the program there are fully involved four investment objects and four financial objects. However, in case the investment object is involved in the program just partly, it is possible to employ only the method of intersection. This is the feature distinguishing Dean's model among the traditional graphical methods employed to determine the marginal capital value.

Dean's model is a rather simple model of synchronous investment and financial planning, which for sure may be employed by transport companies. Obviously, Dean's model, like any other simplified model, provides several limitations which are already mentioned at the very beginning of the article. However, from the theoretical point of view, such aspects as assumptions regarding the independence of investment objects and the objects of inter-financing, as well as limitations of the statistical model and disregarding investment and financial potentialities in future, may be subjected to criticism. Still the faults that can be found with this model are less powerful than the potentialities, which can be aimed at synchronous investment and financial planning.

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MODELS FOR THE ESTIMATION OF THE EFFECTIVENESS OF THE LOGISTIC ACTIVITY OF THE TRANSPORT ENTERPRISE

Marina Pliss, Marina Petrunina

Transport and Telecommunication Institute
Lomonosova 1, Riga, LV-1019, Latvia
Phone: (+371)7100573. Fax: (+371)7100660
E-mail: mpliss@inbox.lv, marina_konovalenko@yahoo.com

Analysing all possible methods of common logistic activity's structure generation for transport enterprise in this work there are offered logistics models of transportation and shipping processes.

A structure of logistic activity for transport enterprise has been shown as a unified system of analytically linked procedures using system creation's principles.

In the description of structure a system approach is taken, as it has a lot of advantages. For the usage of system approach there is defined the following: the aim of logistic activity for transport enterprise, requirements for the system of logistic activity, as well as variances of subsystems for logistic activity.

Theoretical models that are offered in this work allow us to get common procedure of efficiency estimation of logistic activity for transport enterprise.

Keywords: logistics model, regularity, efficiency estimation

1. INTRODUCTION

Nowadays transport has organically entered industrial and trading processes. Therefore transport component takes a great part of numerous problem solutions in logistics. At the same time there is a self-sufficing transport field in logistics where multifunctional coordination between all participants of transport process could be shown without direct linkage to coordinated manufacture-warehouse movement sectors of material flow.

Main task of transport logistics is a solution that strengthens the coordination of actions between all participants of transport process.

The usage of logistics in transport field as well as in manufacture or in trading fields changes counterpart and rival companies into partners that have complementary relationship in transportation process. That means that logistics has unified technical solutions, technology, economics and logistical data. Thus, the main tasks of transport logistics should be technical and engineering coordination support between all participants of transportation process, reconciliation of participant's economical interests as well as usage of unified planning systems.

If you have a task complex like when you are organizing the logistic activity of transport enterprises, the up-to-date problem will be a choice of methods and tools for efficiency estimation of logistic activity.

2. PROBLEMS OF EFFICIENCY ESTIMATION OF LOGISTIC ACTIVITY FOR TRANSPORT ENTERPRISE

Nowadays you can find that there is an expression like efficiency of logistic system [1]. This is value of work quality characteristics for concrete system with determined level of logistical costs.

Very often two quality coefficients are used: grading of service and costs [2]. However, the coefficient of service grading is very subjective. As it couldn't be calculated and should be described with the help of measurable value set.

It is possible to tackle problem of efficiency estimation for business unit of logistic activity again using one more pitch – Balanced Score Card (BSC). A method of BSC regularity should take into account five aspects of enterprise's activity, such as: clients, finance, internal business processes, education and development and logistics. The aim of BSC adaptation is to allocate main spheres of operation for the enterprise and then, to set assemblage of mean measures of efficiency, that should be measured systematically basing on data from accounting information system [3]. It should be made by top managers and experts who had analysed logistic business processes for this enterprise. This method supposes usage of different measures of efficiency for different enterprises. Nevertheless such method could help to solve problems only for one enterprise, but not for a system of enterprises.

The main problem is that different measures of efficiency give different and very often conflicted results. Next problem is to select the primary and general measurement of efficiency.

General measurements of logistic activity that are used at enterprises could be the following: characteristics of product delivery to the customer (86%), velocity of stock turnover (76%), recall of product (52%) and expenses for relationship with supplier (48%). Less than a half of all companies are using only expenses as a quality performance in this case.

Those conclusions are confirmed by many researches. For example, Lennox supposes that principal value will have as follows: the accordance of completed order to a promised one (68%), amount of errors in product delivering (57%), damages (57%) and period of time for execution of order (40%) [4].

Obviously, every method that has been shown above there is redundancy of measures and factors that shows us the lack of logical completeness when we are talking about logistic activity's efficiency estimation for transport enterprises.

To our opinion, as well as to Devonshire's point of view, there is common procedure missing [5].

In other words, it is needed to work out a structure or logistics model. And then with its help, it will be possible to improve logistic activity purposively.

3. APPROACHES OF DESIGN OF LOGISTIC ACTIVITY MODEL FOR TRANSPORT ENTERPRISE

A design of logistic model should be made to satisfy necessary but sufficient demands for solving concrete problems in transport logistics. Particularly there is known one method that is based on the following problem's solving [6]:

- unified operational supply of storage / retrieval process;
- selection of kind and type of means of transport;
- efficient determination of delivery routes.

As a process technology for shipping goods a method of concrete shipping process realization is understood. This method divides shipping process into a system with interrelated sequential phases and procedures that are realized more or less identically. And the aim of such system is to achieve high efficiency of shipping goods.

Each technology should have unique solution for each included phase and procedure. Any variation of one procedure could affect the whole chain of the system. Because the more significant deviation of parameters we have from planned parameters, the higher is risk to break the shipping process at all. And the result will not satisfy us.

At the beginning a technology of whole shipping process has been elaborated and then, each phase of the process separately. After elaboration of technology of each phase it is needed to be reviewed as a technological unity.

Between technical solution and technology there is a cause-effect relation, but the main role will be given to technical solution.

In the past shipment process technologies mostly were produced intuitively. Technological processes of cargo shipping were not designed that time with the help of system that consisted of phases and procedures. That's why a lot of shipping processes are not enough effective nowadays.

The elaboration of logistics model could be also made from the position of hierarchic structure of logistic activity [6].

The systems theory states that every system consists of subsystems. And every system is a part of some system. It is settled that every system could be described in terms of system objects, qualities and its linkage. The hierarchy and the amount of subsystems are dependent on inner systems entire complexity only.

Every type of transportation, from local to intermodal shipments, has its own specific particular qualities in technology, organization and in management. But all of them have common technological base that consists of concrete technological shipment scheme with concrete steps or elements. A shipping process on each step could be shown as definite subsystem. In such system there a regime and management control is represented with step synchronization on every step. In its turn shipping systems elements are described with their definite regularity.

In technical and economic literature there isn't any explanation of numerous fundamental notions, such as: haulage process, transportation process and cycle of transportation process, transport system, transportation complex e.g. shipping process procedures are not heterogeneous and really differs with its duration.

Some procedures after running into one produce definite steps of this process, where after each step a concrete mission has accomplished. Separate procedures as well as shipment process steps are in definite interdependence (before transportation, a shipment should be loaded first, etc.). In such a way our shipping process is a multistage and multifunction process with technological, operational and economic procedures heterogeneity.

Separate steps of shipping process are often considered as self-sufficing procedure. Because of this at the present time in literature there are mentioned the following: shipping process, transportation process, handling process, etc.

General properties of transport system elements are shown in Table 1 [1].

Table 1. General properties of transport system elements

Transport system elements:	**General properties:**
Shipment	Weight; volume; physical, chemical or biological properties; type of packaging
Shipment lying-up area	Location of shipment consignors and consignees
Transport network	Configuration, distance, type of route (pendulum or circle)
Rolling stock	Tonnage lift, cargo capacity, supply traffic
Freight handling facilities	Handling time of one unit of the cargo

A method of logistic activity's structure description for transport enterprise that is shown above is too common for us. As there is no possibility to find out in this structure any analytical linkage between its elements and because of lack of "unified explanation for general features".

4. A MODEL OF LOGISTIC ACTIVITY FOR TRANSPORT ENTERPRISE WITH USAGE OF SYSTEM APPROACH

Logistic activity's structure description for transport enterprise can be made as a unified system of analytically linked procedures using principles of systems generation.

As a system set of elements with links and interrelations between each other and with definite entirety is taken.

This system should have the following properties [2]:

- Entirety – a system is entire set of elements with interrelationship between each other.
- Dividedness – in a system there can be allocated separate elements which can exist as self-sufficient objects.
- Cohesiveness – there is substantial linkage between elements of a system that with regular necessity can define integrative properties of this system.
- Organization – if our system's elements have factors that generate a system, so there can be a proposal of such system creation only.
- Integrative – when a system has integrative properties that are typical to the whole system, but not to only one separate system element.

At present there exist two ways of system's creation that is presented on Figure 1:

Classical approach	**System approach**
Aims of separate subsystems A_1.................A_i ↓ Data bases of subsystems D_{11}.................$\mathbf{D}_{ij}$ ↓ Subsystem complex **1.................I**	Aim of the system **A** ↓ System requirements R_1.................$\mathbf{R}_i$ ↓ Variants of subsystems S_1.................$\mathbf{S}_j$ ↓ <u>SYSTEM</u> Connected subsystems

Fig. 1. *Ways of systems creation*

In our opinion, when a structure of logistic activity for transport enterprise as a uniform system of analytically linked procedures is described, we have to prefer system approach. As it have the following advantages:

- Basing on system approach we have coherent transition from the general to the special, from macro-level to micro-level.
- Basing on system approach we have features adjustment of planned subsystems.
- Basing on system approach there is aim adjustment of separate elements and subsystems with a common aim of the whole system.

In this way on behalf of system approach it is needed to be defined:

- The aim of logistic activity for transport enterprise.
- System requirements for logistic activity for transport enterprise.
- Variants of subsystems of logistic activity for transport enterprise.

The aim of logistic activity for transport enterprise is specified by common aim of logistics. That means that concrete shipment with necessary quality level and in needed quantity should be delivered to correct consignee in concrete place in time with minimum costs as well as for passengers flow correspondingly [7].

System requirements for logistic activity for transport enterprise taking into account shipping process could be specified like:

- ✓ system should guarantee the matching of received cargo to the shipped;
- ✓ system should have the possibility to withstand risk factors;
- ✓ system should assure scheduled supply traffic.

Subsystems variants.

On the point of view of telecommunication systems theory, in every transportation system where electrical signals or objects with weight, volume and other features exist, there is definitely a process sequence like this:

1. Object (shipment) transformation in a convenient form for transportation.
2. Additional transformation of shipping object in a special form that will protect from illegal access as well as from malicious or accidental damage in transportation process.
3. Selection of means of transport, and its creation if needed.
4. Pressing of shipped object to the vehicle.
5. Energy providing for the vehicle with shipped object.
6. The vehicle adjustment to a background where transportation takes place.
7. The estimation of costs and unavoidable losses that are caused by risk factors during transportation in specified background.
8. The vehicle adjustment at the exit of a background where transportation takes place with a background where shipped object shall be received.

9. After transportation through the background the identification of with shipped object is needed; and our vehicle could be provided with energy if needed.
10. Discharging our vehicle
11. Releasing of shipping object from a special form that protected object from illegal access as well as from malicious or accidental damage in transportation process.
12. Backward transformation of shipped object in a convenient form for consignee.

All above mentioned processes could be illustrated in scheme on figure 2. Numbers in rectangular boxes (on fig.2) are in accordance with procedures mentioned above.

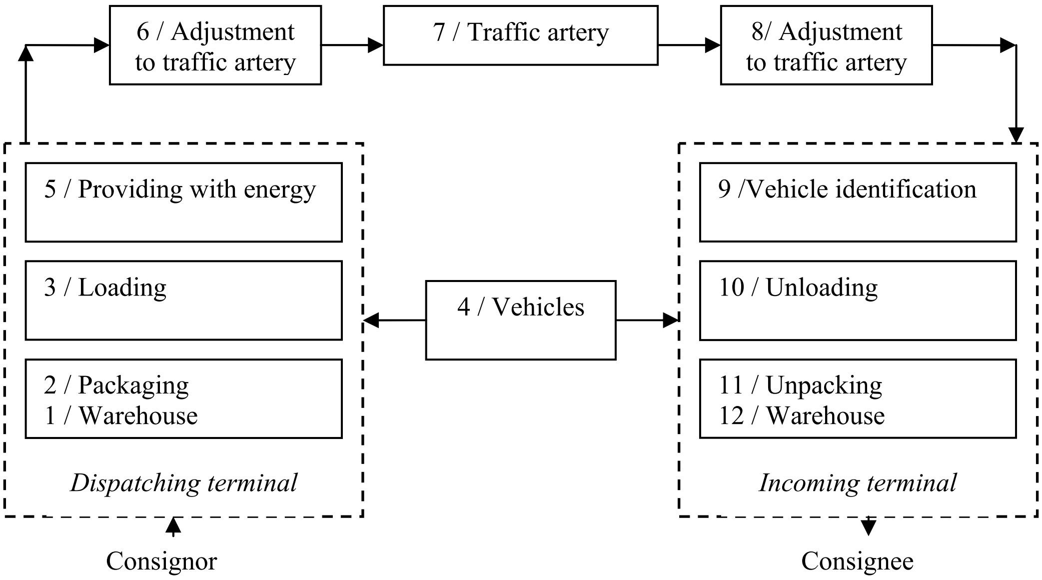

Fig. 2. *Logistics model of transportation*

Reformulating from the point of view of shipping process aims and requirements of logistic activity's system of transport enterprise it is possible to get a different scheme of model from that that is shown on Figure 2. The model will exclude warehousing, packaging and unpacking procedures. As well as it can have a feed-back circuit where procedures similar to procedures 3, 7, 10 (see on Fig.2) take place.

CONCLUSION

In accordance with the shown models for efficiency estimation of transport enterprise it is needed to:

1) define quantitative characteristics that describe system's ability to match the presented requirements;

2) describe each procedure inside the system taking into account how it influences the mentioned-above characteristics;

3) compose transparent equation that describes our system with every measure of quantity;

4) evaluate system's efficiency in accordance with priority measure of quantity from clause 3.

In this work it is revealed that potentially shown models help us to receive a common procedure of efficiency estimation of transport enterprise.

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INVENTORY CONTROL MODELS CLASSIFICATION

Edvin Puzinkevich

Transport and Telecommunication Institute
Parades 1, Daugavpils, LV-5400, Latvia
Phone: 26756030. E-mail: edvins.puzinkevics@du.lv

Keywords: inventory control models, classification, criterion function

Most of the inventory control models exist because of big variety of real situation in storekeeping on warehouses, manufacture control and because of various restrictions and assumptions, which are provided by models [1-5].

Inventory control models can be classified using various properties of inventory system, for example:

- by quantity of nomenclatures (single-product and multiproduct),
- by quantity of the observed periods (one-period and multiperiod),
- by the character of the observed processes (determined and stochastic),
- by existence of restrictions (with restrictions and without restrictions);
- by the type of the delivering (direct delivering and intermediary delivering);
- by the type of inventory level tracking (with continuous inventory level tracking and without tracking), etc.

The author in the article observes the models classification where the basic attribute is a criterion function. The main parts of the criterion function are as follows:

- expenses on inventory ordering;
- expenses on inventory holding;
- losses from deficit;
- inventory losses, etc.

Moreover separate components can be classified, for instance, losses from deficit may be related either with demand specifics or with delivery time stochastic character.

Report presents the algorithm for definition of group to which belongs a model, depending on its criterion function attributes.

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THE POPULARITY OF STUDY PROGRAMMES IN TRANSPORT ENGINEERING AND TELECOMMUNICATION ENGINEERING AMONG THE APPLICANTS TO LITHUANIAN HIGHER SCHOOLS

Olegas Prentkovskis[1], Romualdas Kliukas[2], Alfonsas Daniūnas[3]

Vilnius Gediminas Technical University, Admission Office of Applicants
[1]Plytinės g. 27, Vilnius, LT-10105, Lithuania. E-mail: olegas@ti.vgtu.lt
[2]Saulėtekio al. 11, Vilnius, LT-10223, Lithuania. E-mail: pirmininkas@adm.vgtu.lt
[3]Saulėtekio al. 11, Vilnius, LT-10223, Lithuania. E-mail: alfonsas.daniunas@adm.vgtu.lt

The operation of industrial, construction and agricultural enterprises as well as work efficiency and public opinion largely depend on reliability and effective performance of transport and telecommunication. The Lithuanian universities train qualified specialists in transport engineering and telecommunication engineering, who are highly appraised in the European Union. The present paper briefly describes a system of joint admission to Lithuanian higher schools which has been already used for several years in this country. The problems of selecting applicants to the Lithuanian universities and the level of knowledge of the applicants admitted to study the programmes in transport engineering and telecommunication engineering will also be discussed in the present paper.

Keywords: Lithuanian universities, applicants, joint admission, transport engineering, telecommunication engineering, study programme, popularity

1. INTRODUCTION

When Lithuania joined the European Union, transport and telecommunication became the most important branches of national economy. Now, the economic development is hardly possible without an effective transport system (providing both local and international transportation) and quality telecommunication system (providing communication within and between the countries). The operation of industrial, construction and agricultural enterprises as well as work efficiency and public opinion largely depend on reliability and effective performance of transport and telecommunication systems [1-4].

Transport and telecommunication are the key branches of economy. The development of economy can hardly be imagined without transport and telecommunication now. The reliable and well organized transport and telecommunication services are required for efficient performance of industry, construction and agriculture. General feeling and the efficiency of people's work also largely depend on transport and telecommunication systems and their performance.

Therefore, satisfying the demand of people for timely provided quality transport and telecommunication services are becoming a social, rather than a merely transport and telecommunication problem, determining the attitude of citizens not only to the level of the provided services, but to all processes, taking place in a particular state as well.

Transport. Increasingly growing transportation by motor vehicles is accompanied by increasing demands for higher quality of transport services and higher efficiency of transport performance.

Harmonized development of state economy requires that more attention be paid to the problems of organization and management of automobile transport by all engaged in providing transport services. This, in turn, requires more effective planning as well as the analysis and evaluation of various economic aspects of the performance of large transport systems and individual motor vehicles. Precise calculation and analysis are key factors in developing rational schemes of energy-efficient freight transportation. Effective economic solutions make a basis for successful development of transport enterprises, ensuring their profitable work.

Transportation mainly relies on vehicles, which are becoming more and more complicated, as far as their design, structures and operation principles are concerned.

One of the main tasks of transport is to increase the amount of the transported goods and to ensure traffic safety.

The operation of transport facilities largely depends on many factors. Most of them have a negative effect on transport performance, e. g. poor roads, inefficient organization of road traffic, poor technical state of transport facilities, bad weather or visibility, high density of traffic flows, the choice of inappropriate motor vehicle speed, etc.

Telecommunication. Technical and technological advance, as well as the development of new information and telecommunication technologies, brought about great changes in our lifestyle and required new approaches to work. Today, small-size powerful electronic devices can often change a number of staff members in the company, while its office may be held in a briefcase. Therefore, it is clear that, in the near future, the equipment needed for works will be miniaturized so that it could be carried on a belt. Wide-spread mobile phones and pagers are living proof of it.

Quite recently, great distances between dwellings and workplaces of employees prevented them from achieving high labour productivity. However, later this obstacle has been removed due to great advances in telecommunication. Work efficiency of people is no longer dependent on their location because they can efficiently work everywhere – at home, in the office and even in a trip. Computers, modems, electronic mail and the Internet allow office workers and businessmen to communicate with their colleagues, exchange data with the web-server of the company, follow the dynamics of stock-exchange and send faxes to customers. All these operations can be performed at any place where they are at the moment.

One of the first organizations in the USA to use telecommunication in its work was the Association for Environment Protection. Some office workers got an opportunity to work and communicate with each other, not coming to the office. Now, plenty of large and small companies consider the possibility to introduce means of telecommunication to perform daily work. This stimulates the development of a new management strategy in the area of means of production. The use of modern telecommunication technologies will enable companies to cut the rents for offices, as well as the number of employees, and to extend the range of jobs and services provided by using more flexible and advanced means of telecommunication with the consulting firms, contractors and suppliers situated in any part of the world.

Another stimulus for a wide use of modern means of telecommunication, especially in large multinational corporations, is sharp international competition. At the end of the 20-th century many companies experienced its strong influence on the methods of work organization and management and began searching for new approaches to raising their competitiveness. Hundreds of managers and vendors realized that precious time can be spent more effectively by making contracts and deals with the clients at a distance, rather than travelling to workplaces. Since that time, information and telecommunication technologies have been increasingly developed to satisfy the demands of the world market in compliance with the new trends of its development, and the achievements in these areas are impressive.

The Lithuanian universities train qualified specialists highly appraised in the European Union in transport engineering and telecommunication engineering [1, 5].

However, employers would like to employ specialists having more practical skills in using advanced technologies and business strategies. These skills can be developed when graduates have worked several years at an enterprise. Moreover, to become a highly qualified specialist, good speciality knowledge acquired at the university, fundamental knowledge of transport or telecommunication engineer's work and friendly environment at an enterprise are required. Such specialists can be trained only when close cooperation is established between universities and transport and telecommunication enterprises.

For many years now, researchers and university teachers have been studying various problems of higher education [6-10], associated with: engineering education and embracing, new trends in teaching strategies, internationalization of university studies at various levels, the development of higher education, continuous university education, selection of applicants to higher and other types of schools and selection of university graduates for qualified jobs at various enterprises.

The problems of selecting applicants to the Lithuanian universities and the level of knowledge of the applicants admitted to study programmes in transport engineering and telecommunication engineering will be discussed in the presented paper.

The paper was being prepared for publishing, when joint applicants' admission for 2007 had just begun; therefore, the statistical data for 2006 were used.

2. JOINT APPLICANTS' ADMISSION TO LITHUANIAN HIGHER SCHOOLS

The Lithuanian higher schools formed an Association of Lithuanian Higher Education Institutions to implement the programme of joint admission [11] helping the applicants to enter a higher school and to reduce the risk of a single possible choice, as well as making the selection of potential students more objective and simplifying the entrance by allowing them to apply to several higher schools simultaneously. Based on this programme, an applicant is given an opportunity to choose a higher school and a study programme according to his/her order of preference and depending on the marks obtained in a secondary school. An applicant submits an application to any of the higher schools of the Association, allowing him/her to select a number of study programmes in several higher schools [1, 5, 11, 12].

Seventeen university-level higher schools and two non-university-level higher schools formed the Association [5, 11] (sixteen higher schools are state-owned and three higher schools are private): General Jonas Žemaitis Military Academy of Lithuania (LKA), International Business School at Vilnius University (VU TVM), Kaunas University of Medicine (KMU), Kaunas University of Technology (KTU), Klaipėda University (KU), Lithuanian Academy of Music and Theatre (LMTA), Lithuanian Academy of Physical Education (LKKA), Lithuanian University of Agriculture (LŽŪU), Lithuanian Veterinary Academy (LVA), Mykolas Romeris University (MRU), Šiauliai University (ŠU), University of Management and Economics (ISM), Vilnius Academy of Fine Arts (VDA), Vilnius College of Higher Education (VK), Vilnius Gediminas Technical University (VGTU), Vilnius Law and Business College (VTVK), Vilnius Pedagogical University (VPU), Vilnius University (VU), Vytautas Magnus University (VDU).

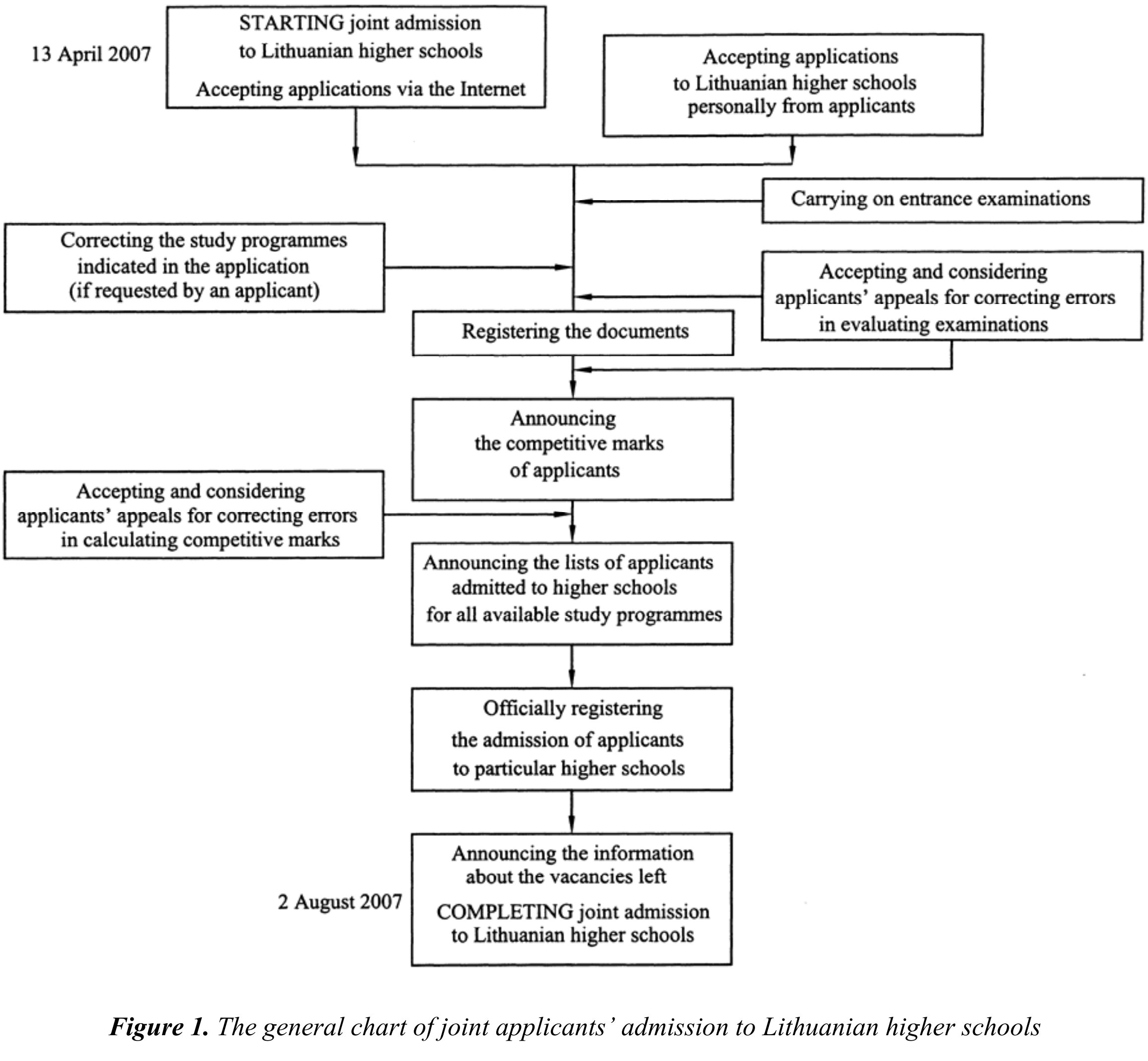

Figure 1. *The general chart of joint applicants' admission to Lithuanian higher schools*

In 2006, the Lithuanian higher schools participating in joint applicants' admission programme offered the applicants 747 study programmes: full-time (daytime) studies, part-time (evening) studies, part-time (extra-mural) studies in 62 study fields, which make 6 study areas groups: technological science, social science, physical science, biomedicine science, humanities and fine arts.

Figure 1 presents a general chart of joint applicants' admission to Lithuanian higher schools.

An applicant, participating in the joint admission programme, can mention up to twenty study programmes (choices) in the application to study at any Lithuanian higher school. Study programmes are arranged in the order of preferences in the application. The name of the higher school, form of studies and financing are indicated for every study programme [1, 5, 11, 12]. The applicant is admitted to a higher school to study one of the study programmes included in his/her application, which is determined by computer after calculating his/her competitive mark. When the first study programme from the list of applicant's preferences is found, for which the calculated competitive mark satisfies the requirements of admission, all other study programmes given below in the list are not considered (though the mark is sufficient for an applicant to be admitted to study them).

Higher schools can admit up to 20 % more students to take the available study programmes than planned by the Ministry of Education and Science of the Republic of Lithuania. In such cases, a higher school is financed, based on the number of students indicated in the plan approved by the Ministry of Education and Science of the Republic of Lithuania.

3. A BRIEF REVIEW OF STUDY PROGRAMMES IN TRANSPORT ENGINEERING AND TELECOMMUNICATION ENGINEERING

Four of the above-mentioned higher schools offer the study programmes in transport engineering and telecommunication engineering, leading to Bachelor's degree (qualifications: *Bachelor of Transport Engineering* or *Bachelor of Electronic Engineering*) [1, 5, 11, 13-16]. They are as follows:

- Vilnius Gediminas Technical University,
- Kaunas University of Technology,
- Klaipėda University,
- Vilnius University.

Figure 2 presents a map of Lithuania showing the location of these universities and the available study programmes in transport engineering and telecommunication engineering belonging to the field of technological sciences.

Much more students are admitted to full-time studies of transport engineering and telecommunication engineering than to part-time studies and distant learning. Further, the data on the selection of applicants to full-time studies will be analysed.

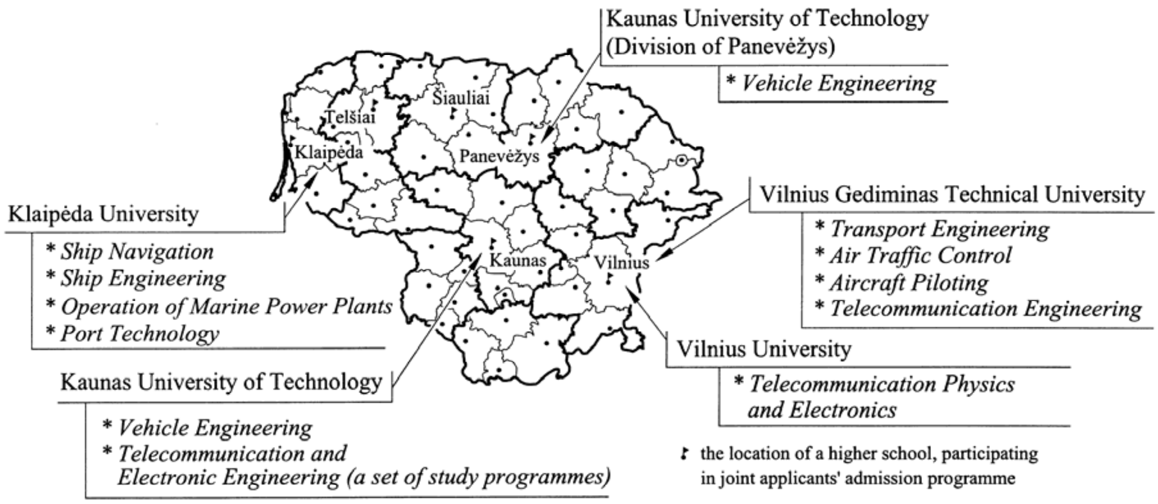

Figure 2. *A map of Lithuania, showing the location of universities providing study programmes in transport engineering and telecommunication engineering*

Competitive marks [5, 11, 13-16] of the applicants to study according to the programmes in transport engineering and telecommunication engineering at various Lithuanian universities are presented in Table 1, while the highest marks (without any additional points) are presented in Table 2.

Table 1. Competitive marks of applicants to study according to the programmes in transport engineering and telecommunication engineering at Lithuanian universities

<table>
<tr><th>Examination mark at school</th><th>Weighted coefficient</th><th>A yearly mark in school-leaving certificate</th><th>Weighted coefficient</th></tr>
<tr><td colspan="4">Vilnius Gediminas Technical University:
Transport Engineering – Bachelor of Transport Engineering
Air Traffic Control – Bachelor of Transport Engineering
Aircraft Piloting – Bachelor of Transport Engineering
Telecommunication Engineering – Bachelor of Electronic Engineering</td></tr>
<tr><td>mathematics</td><td>0,50</td><td rowspan="3">the foreign language</td><td rowspan="3">0,15</td></tr>
<tr><td>the Lithuanian language (test)</td><td>0,20</td></tr>
<tr><td>physics</td><td>0,15</td></tr>
<tr><td colspan="4">Kaunas University of Technology:
Vehicle Engineering – Bachelor of Transport Engineering
Telecommunication and Electronic Engineering (a set of study programmes) – Bachelor of Electronic Engineering</td></tr>
<tr><td>mathematics</td><td>0,50</td><td></td><td></td></tr>
<tr><td>the Lithuanian language (test)</td><td>0,20</td><td></td><td></td></tr>
<tr><td>physics</td><td>0,20</td><td></td><td></td></tr>
<tr><td>the foreign language</td><td>0,10</td><td></td><td></td></tr>
<tr><td colspan="4">Klaipėda University:
Ship Engineering – Bachelor of Transport Engineering
Port Technology – Bachelor of Transport Engineering</td></tr>
<tr><td>mathematics</td><td>0,38</td><td>mathematics</td><td>0,17</td></tr>
<tr><td>physics or information technologies</td><td>0,25</td><td>physics or information technologies</td><td>0,10</td></tr>
<tr><td>the foreign language</td><td>0,06</td><td>the foreign language</td><td>0,04</td></tr>
<tr><td colspan="4">Klaipėda University:
Ship Navigation – Bachelor of Transport Engineering
Operation of Marine Power Plants – Bachelor of Transport Engineering</td></tr>
<tr><td>mathematics</td><td>0,33</td><td>mathematics</td><td>0,12</td></tr>
<tr><td>physics</td><td>0,25</td><td>physics</td><td>0,10</td></tr>
<tr><td>the foreign language</td><td>0,15</td><td>the foreign language</td><td>0,05</td></tr>
<tr><td colspan="4">Vilnius University:
Telecommunication Physics and Electronics – Bachelor of Electronics Engineering</td></tr>
<tr><td>physics</td><td>50,00</td><td>the foreign language</td><td>9,00</td></tr>
<tr><td>mathematics</td><td>25,00</td><td>physics</td><td>4,00</td></tr>
<tr><td>the Lithuanian language (test)</td><td>7,00</td><td>mathematics</td><td>3,00</td></tr>
<tr><td colspan="2"></td><td>the Lithuanian language</td><td>2,00</td></tr>
</table>

Table 2. The highest competitive marks (without any additional points) of the applicants to study according to the programmes in transport engineering and telecommunication engineering at Lithuanian universities

<table>
<tr><th>Study programme</th><th>The highest competitive mark</th></tr>
<tr><td colspan="2">Vilnius Gediminas Technical University:</td></tr>
<tr><td>Transport Engineering</td><td rowspan="4">21,35</td></tr>
<tr><td>Air Traffic Control</td></tr>
<tr><td>Aircraft Piloting</td></tr>
<tr><td>Telecommunication Engineering</td></tr>
<tr><td colspan="2">Kaunas University of Technology:</td></tr>
<tr><td>Vehicle Engineering</td><td rowspan="2">21,90</td></tr>
<tr><td>Telecommunication and Electronic Engineering (a set of study programmes)</td></tr>
<tr><td colspan="2">Klaipėda University:</td></tr>
<tr><td>Ship Engineering</td><td rowspan="2">19,59</td></tr>
<tr><td>Port Technology</td></tr>
<tr><td>Ship Navigation</td><td rowspan="2">20,03</td></tr>
<tr><td>Operation of Marine Power Plants</td></tr>
<tr><td colspan="2">Vilnius University:</td></tr>
<tr><td>Telecommunication Physics and Electronics</td><td>2102,00</td></tr>
</table>

4. POPULARITY OF STUDY PROGRAMMES WITH THE APPLICANTS, PARTICIPATING IN JOINT ADMISSION TO LITHUANIAN HIGHER SCHOOLS

As mentioned above, an applicant can submit one application to the Association of Lithuanian Higher Education Institutions, allowing him/her to apply to several higher schools and for several (up to twenty) study programmes simultaneously. In this application, up to twenty various study programmes may be mentioned.

The popularity of particular sciences with school-leavers varies to a large extent (see Figure 3). Study programmes in transport engineering and telecommunication engineering are the study programmes of technological sciences. The popularity of technological sciences (in 2001-2006) is demonstrated in Figure 4 [1, 17].

Twenty most popular study programmes, based on the analysis of all applications submitted by school-leavers to study at Lithuanian higher schools according to joint admission programme are given in Table 3 [17]. Some of the considered specialities are among the top twenty most popular specialities shown in grey colour in Table 3.

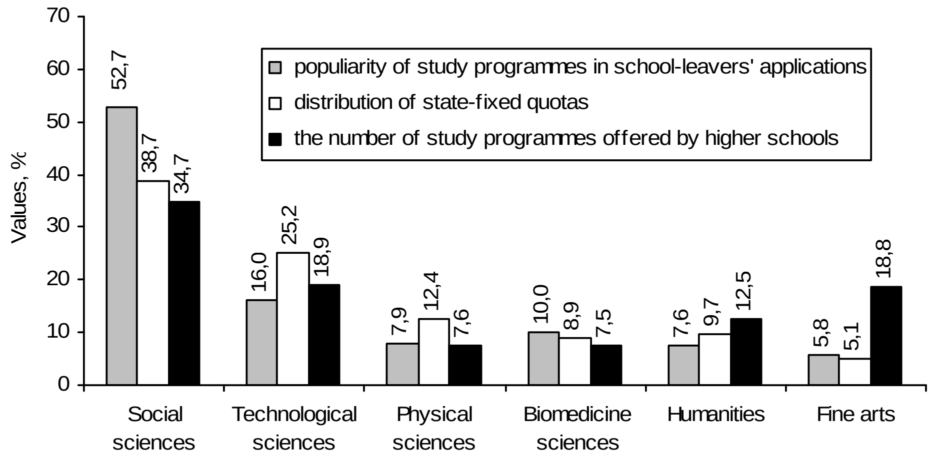

Figure 3. *Popularity of study programmes according to the study areas in 2006*

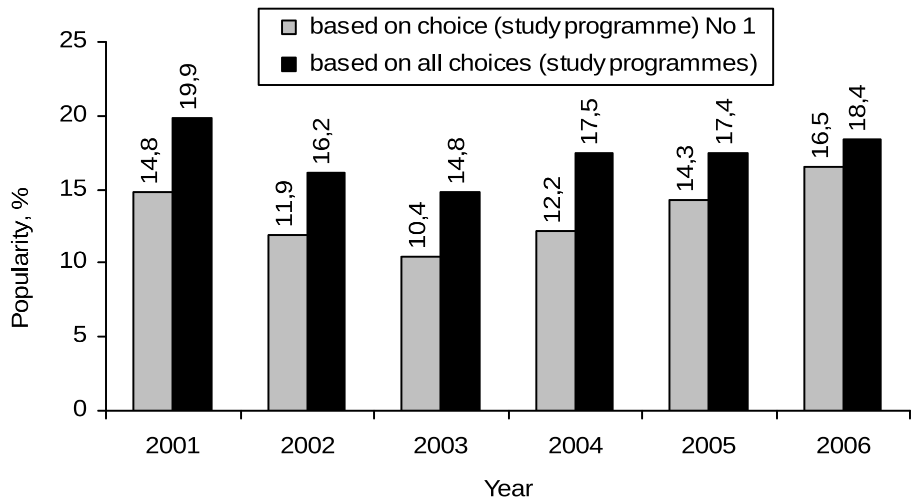

Figure 4. *Popularity of study programmes in technological sciences in 2001–2006, in per cent (the number of applicants to all study programmes is assumed to be equal to 100 %)*

Table 3. Most popular study programmes in technological science in 2006 according to the number of applicants' choices

No	Higher school	Study programme indicated in applications	Number of choices
1.	VGTU	Construction Engineering	2818
2.	VGTU	Transport Engineering	1910
3.	KTU	Civil Engineering	1809
4.	VGTU	Civil Engineering	1632
5.	VGTU	Environmental Engineering	1592
6.	VGTU	Telecommunication Engineering	1412
7.	VGTU	Industrial Engineering	1402
8.	KTU	Telecommunication and Electronic Engineering	1263
9.	VGTU	Geodesy	1229
10.	VGTU	Mechanical Engineering	1085
11.	KTU	Automation, Control and Electrical Power Engineering Technologies	1049
12.	KTU	Mechanical Engineering	1025
13.	VGTU	Automation and Control	1024
14.	VGTU	Computer Engineering	1019
15.	KTU	Vehicle Engineering	975
16.	VGTU	Information Systems Engineering	975
17.	VGTU	Electronic Engineering	963
18.	VGTU	Building Energetic	927
19.	KTU	Informatics Engineering	919
20.	LŽŪU	Land Management	907

The *competitiveness index* [1] shows the preparation for studies and intellectual potential of the admitted to a particular study programme. It is calculated as the average mark of the key subjects in the school-leaving certificates of all admitted to study this programme.

The competitiveness index of the admitted to study a particular study programme is calculated in the following way:

$$I_c = \frac{\sum_{i=1}^{m} \left(\frac{LL + M + P + FL + H}{5} \right)_i}{m},$$

where: I_c is a competitiveness index of the admitted to a particular study programme; m is the number of the admitted to the study programme; LL is a mark for the Lithuanian language in school-leaving certificate; M is a mark for mathematics in school-leaving certificate; P is a mark for physics in school-leaving certificate; FL is a mark for the foreign language; H is a mark for history in school-leaving certificate.

To calculate I_c, a mark obtained at the secondary school-leaving state examination [1, 5, 11, 12] is considered. If this exam has not been taken, the mark obtained at school-leaving examination is considered.

The competitiveness index shows the competitiveness of an applicant to study any programmes at a higher school (compared to other applicants). The higher is the competitiveness index of a study programme, the higher is the general level of education of a person admitted to study a particular programme.

The highest possible competitiveness index for the best applicant is equal to $I_c = 23$.

Competitiveness indices of full-time studies in transport engineering and telecommunication engineering university-level study programmes are given in Figure 5. As it is shown on the chart, more qualified applicants are admitted to the study programme in transport engineering – VGTU Aircraft Piloting, and in telecommunication engineering – VU Telecommunication Physics and Electronics.

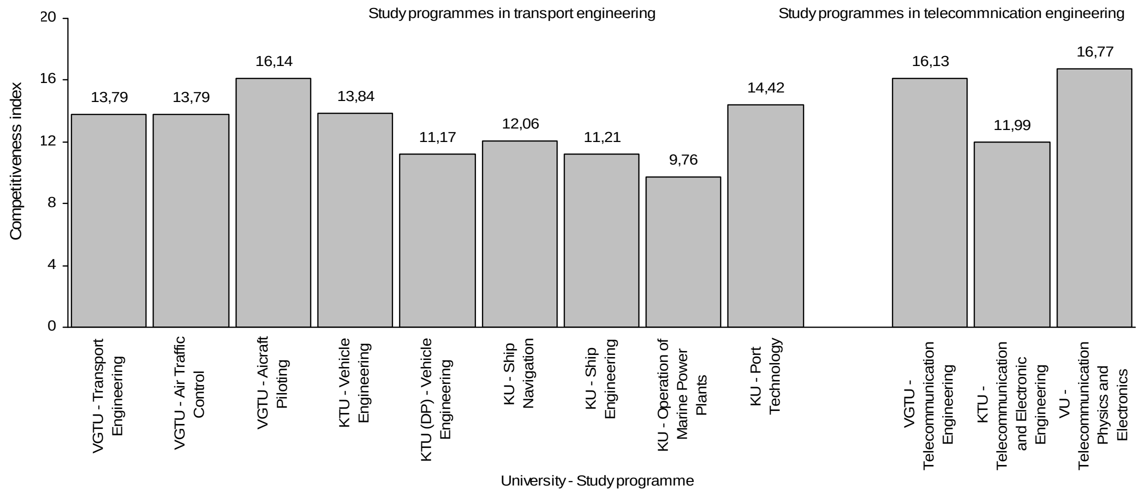

Figure 5. *Competitiveness indices of full-time studies in transport engineering and telecommunication engineering university-level study programmes in 2006*

Training of a qualified specialist depend not only on the number of qualified university teachers, well-equipped laboratories and training centres, but also on the thirst for knowledge and eagerness of an applicant to become a qualified specialist in the selected field, i.e. his/her motivation. Motivation is reflected by the order of preference given by an applicant to a particular study programme in the application to a higher school.

The *motivation index* [1] is calculated by the following formula:

$$I_m = \frac{\sum_{i=1}^{m} O_i}{m},$$

where: I_m is a motivation index of a particular study programme; O_i is the order of preference (No) given by the i-th applicant to a particular study programme; m is the number of applicants admitted to a particular study programme.

The lower is the index value; the higher is the motivation of applicants taking a particular study programme. The ideal motivation index is $I_m = 1$, when all school-leavers admitted to a particular study programme mention it in the application as choice No 1.

Motivation indexes of full-time studies in transport engineering and telecommunication engineering university-level study programmes are given in Figure 6. As it is shown on the chart, more highly motivated applicants are admitted to study programme in transport engineering – VGTU Aircraft Piloting, and in telecommunication engineering – VU Telecommunication Physics and Electronics.

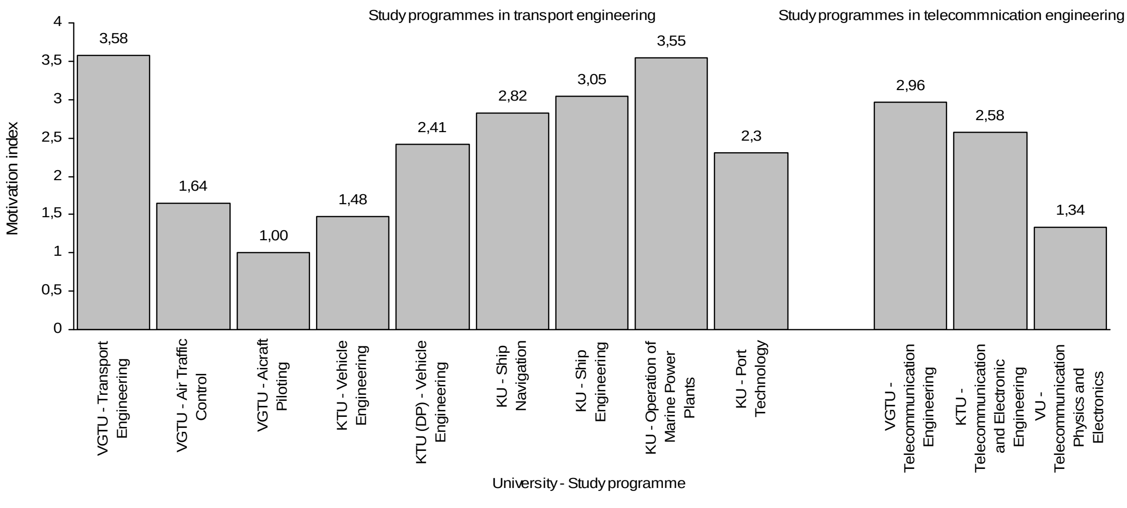

Figure 6. *Motivation indices of full-time studies in transport engineering and telecommunication engineering university-level study programmes in 2006*

CONCLUSIONS

1. A modern system of joint admission of school-leavers to higher schools (universities and colleges) has been developed and implemented in Lithuania. The system of joint admission described in the present paper facilitates the process of applicants' admission to higher schools, increases objectivity of potential students' selection, simplifies the formal procedure of admitting the applicants, allowing them to apply to several higher schools simultaneously, eliminates the risk of a single possible choice of speciality and higher school, and gives school-leavers time for relaxation before starting the studies at a higher school.
2. Nowadays, study programmes in transport engineering and telecommunication engineering are among the most popular programmes in technological sciences.
3. The educational level of the applicants and those admitted to take various study programmes can be defined by their competitive marks and competitiveness indices.
4. The competitiveness index shows the preparation for studies and intellectual potential of applicant admitted to a particular study programme.
5. Motivation is reflected by the order of preference given by an applicant to a particular study programme in the application for admission to a higher school.
6. The graduates, completing the study programmes in technological sciences, actually have no employment problems. Specialists of transport engineering and telecommunication engineering have not been found in the lists of the unemployed registered at the National Labour Exchange of Lithuania.

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