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RELEVANT FACTORS FOR IMPROVING THE LOGISTICS PERFORMANCE IN SUPPLY CHAINS

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Abstract: This paper analyzes three important elements for improving logistics performance in supply chains. The first important component of the supply chain refers to the reduction of traffic, correspondence and communication lines, the second refers to the process of balancing by layers of the activities and the third important component relates to micro processes of differently balanced states of units to generate the best compositions. Factors in terms of control are of strategic, tactical and operational level, the application of which increases the effectiveness and efficiency of logistic systems. This paper pays attention to the factors of efficiency in logistics centers, i.e. in processes and operations as a function of compositional equilibrium of status and location changes of loading units.

Keywords: supply chain management, processes and operations, composition, balance.

1. INTRODUCTION

From the point of view of logistical research based on multidisciplinary and interdisciplinary knowledge aimed at implementing the generated legality in the field of planning, organization, technology, control, modeling and simulation of material flow, energy and information, a special emphasis is placed on supply chain management [1,2]. In practical terms, the logistics has a role in creating the environment and giving support to increase the effectiveness, efficiency and propulsion of materials, energy and information in the functional organization of life and work [3]. In the logistics and transportation services market, there are usually demands in terms of the flow of material goods and transport units that formally represents a graph „tree" [4,5,6]. The carrying out of the process and operations in graph form the „tree" has its own characteristics that can be used to balance the classes of activities, to achieve efficient solutions. A logistics center, as a relevant link of supply chain aimed at the flow of material, energy and information, in general, has a good feature to reduce the number of traffic lines (exchange of information, correspondence, materials flow) between the sender → receiver [9]. As at the entrance in a logistics center transport and cargo units of different manifestation in concentration and classification arrive, under the influence of process and operations they change a status and micro locations in the logistics center, thus generating various compositions and diversify and decompose at the exit [10]. The different composition and decomposition of the status and location changes of loading units in the logistics center results in either lower or higher efficiency.

2. LOGISTICS CENTERS IN MEDIATION FUNCTION

In order to understand more clearly the role of the logistics center, the requirements at the entrance are given on a simple example, through one request-scope attribute. Scope means the level of distribution requirements between the potential participants in its implementation, i. e. distribution requirements in multiple implementers, organizers and distributors. In case that a customer (user) makes a request toward only one participant, then this request is considered simple and comprehensive. In this case, communication, exchange of information and correspondence relating to the application are single line, and if we have „N_{xy}" (X−sender and Y−recipient and

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implementer) participants then multiple independent lines may appear of information, communication and correspondence sharing.

Figure 1 represents a formalized partial network communication, correspondence and traffic between senders, and facilitators, where there are no logistical nodes, follows: *X1 → {Y1, Y2 ... Y12}, and x12 → {Y1, Y2 ... Y12} and Y1 → {x1, x2 ... x12 and y12} → {x1, x2 ... x12}* [11−13]. It is easy to see that the network of traffic lines ("everyone with everyone") between the sender-receiver is very complicated. [7,8,10]. Formally written, when we have a set of X senders and Y recipients (and vice versa), the number of lines N_{xy} is:

$$N_{xy} = \sum_{i=1}^{n} x_i \cdot \sum_{j=1}^{m} y_j \qquad (1)$$

or simpler:

$N_{xy} = X \cdot Y$.

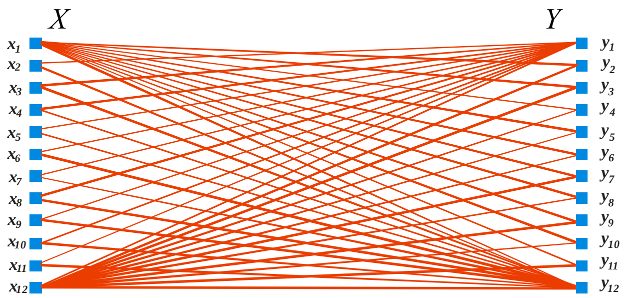


Figure 1. Partly illustrated connection (traffic, correspondence and communication) sets X and Y

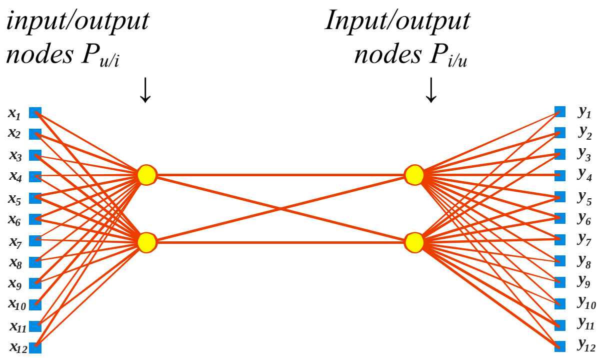


Figure 2. Complete connection of X and Y generated using logistic nodes (centers)

With complicated networks, during the realization of technological processes and operations, intermediaries (providers) are introduced [8, 12, 13], Figure 2. When introducing a set of intermediaries (denoted by), the P number of traffic lines between X ↔ Y is conditionally reduced and amounts to:

$$N_p = X \cdot P_{u/i} + P_{u/i} \cdot P_{i/u} + P_{i/u} \cdot Y \qquad (2)$$

Where:

N_p − Number of traffic, corresponding and communication lines,

$P_{u/i}$ − the number of input/output and intermediaries,

$P_{i/u}$ − number of output/input intermediaries.

Number of lines is reduced under the condition $N_p < N$. In order to meet the above-mentioned, by incorporating or replacement of values from (1.1) and (2.2) it should be:

$$X \cdot P_{u/i} + P_{u/i} \cdot P_{i/u} + P_{i/u} \cdot Y < X \cdot Y \qquad (3)$$

By introduction of stricter variants i.e.

$P = max\,(P_{u/i}\,;\,P_{i/u})$ should be:

$$X \cdot P + P^2 + Y \cdot P < X \cdot Y \qquad (4)$$

$X \cdot P + P^2 + Y \cdot P - X \cdot Y < 0$ (or) $P^2 + P(X+Y) - XY < 0$

$$P < \frac{-(X+Y)}{2} + \frac{\sqrt{(X+Y)^2 + 4XY}}{2} \qquad (5)$$

It is logical to take only the integer values. If, for example: $X = 10$ *and* $Y = 10$, $\max P\,(P_{u/i},\, P_{i/u}) \leq 4$. However, in practice, the number of intermediaries in relation to the number of clients in the correspondence and communication is many times smaller, so that the number of communication lines is smaller by about the same number (due to linear dependence). When senders among themselves perform the exchange of information *(X ↔ X, Y ↔ Y)* then the full coverage of the number of lines in interactive exchanges is:

- between senders

$$Nx \cdot X = (X-1)/2 \qquad (6)$$

and by analogy

- between the organizers and executors

$$Ny = Y \cdot (Y-1)/2 \qquad (7)$$

Therefore, the full coverage line of information exchange, by summing up the equations (1), (6) and (7), amounts to

$$N = X \cdot Y + X\,(X-1)/2 + Y \cdot (Y-1)/2 \qquad (8)$$

These attributes, in practical terms have generated a network of logistics centers (nodes) as the relevant agents in the international flow of materials. With the reduction in the number of traffic, corresponding lines and communication, the introduction of intermediaries, several objectives are achieved [10,12]:

- reducing the number of roads and easier maintenance of the existing ones,

- generating more alternatives with synergetic transactions,
- reduction of energy consumption, especially fragmentation of cargo,
- simpler and easier manageability levels of noise and pollution,
- savings in correspondence and communications.

The classified concentration is advantageous from the point of view of generating multiple alternatives and selecting the most suitable on for the requirements of „just in time" and implementation in accordance with the requirements of modern transport, decomposition and diversification.

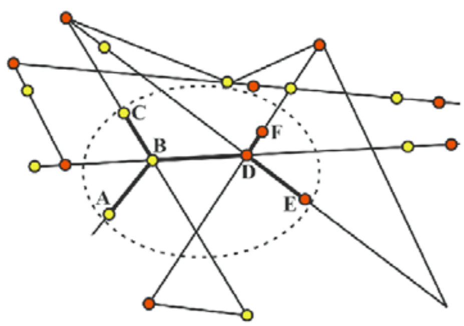
3. LOGISTICAL BALANCING ON THE NETWORK AND INTRODUCTION OF THE CONCEPT OF COMPOSITION

3.1. Balancing on an example of the distribution of empty freight units between logistics centers in the graph form „tree"

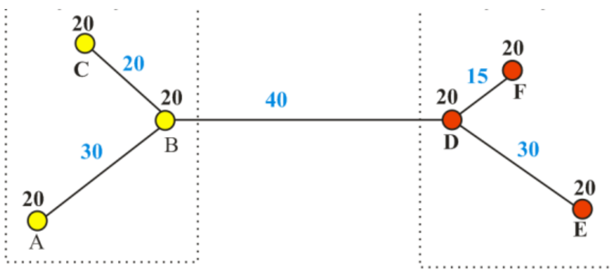
In formulating the function of objective by assigning the criteria of distance and time and the necessary limitations with the use of appropriate algorithms optimal solutions are obtained, but only for the given criteria. Such solutions certainly raise the level of efficiency by implementing the processes and activities, but must be improved by using the logistical balancing by engagement of layers in order to have a practical application [7−8].

For a better illustration of the case, Figure 3 represents a network a) and b) an extract of one optimal solution of the transport task of distribution of empty transport units from logistics centers A, B and C in logistics centers D, E and F in the graph form of a „tree" [4−6,10]. The extract shows that 20 empty transport units (of equal technical and technological characteristics) are dispatched from the logistics centers A, B and C to logistics centers D, E and F for loading. Each realization of the above extract from the optimal plan gives a minimum function value of the objective with respect to the given criteria. In the middle of the arches are given the values of distance between adjacent nodes.

On graph image in Figure 3b it is easy to conclude that any given realization (model) of distribution in the objective function according to the criterion of distance generates the same values (units x kilometer). Also, if the chosen criterion is time, the same values of the objective function will be realized (units x hours). The minimum objective function of this network is 4300 (units x criterion). In available algorithms (given with software) this setting is often ignored, but frequently in practical logistic application of a variant (alternative), distributions are not effective. As 9 alternatives exist, it is often necessary to seek the most balanced approach. For the purpose of balancing in Table 1 the distance between corresponding points and the shaded most balanced correspondence is presented.



a) Network



b) Excerption from graph network „tree"

LEGEND:
- location of empty units
- location of required load

Figure 3. The network as a function of distribution of empty units at the required location of loading

Table 1. The mutual distance of dispatch and receipt

Confluence → / Source ↓	D	E	F
A	70	100	85
B	40	70	55
C	60	90	75

Therefore, it is necessary to establish the approximate (logistic) balance when in the points A, B and C there are empty loading units of different companies to be transported to the points of loading, provided that they all are equally (fair) loaded with empty runs [13]. Given the fact that the flow of units A, B and C to destination D, E and F are often independent and different in the ownership structure, but are dependent on a stretch of road B → D, the formalization of criteria and constraints is not easy. Also, when on the front it takes approximately the same time to deliver empty transport units (buses, trains) for the withdrawal of men and material from the front or around the same time to occupy points D, E and F and others, it is essential to proceed to balancing.

The best solution of balancing is the one with the smallest fluctuations around the average value of the length (time) i. e. 4300/60 = 71.667**.**

So, if in logistics balance is required, then the optimal objective function with the use of criteria for route and time constraints (available algorithms) generate alternatives that should be improved again, in terms of logistics, by recomposition of the graphs „tree".

3.2. Abstraction processes and operations in the logistics center and the introduction of the concept of composition

For Logistics centers as logistics nodes, most important compositions of functions are considered by the direction of movement of materials (energy, information). During functioning of the logistics center different units appear at its entrances (shipment of different levels of concentration and classification, vehicles, integrated and intermodal units, etc.) where various forms of functional organized and planned combination in order to generate a composition of units of different events at the output (picking, manipulation, sorting etc.) are performed. In Figure 4 with the input devices in the logistics node are abstracted by way of dices of different colors, which, to the entrance to the logistics node go through the processes and activities of concentration and classification. Cubes can be quantified so they are considered (analyzed) by using a predicate. If the dices are qualified (qualitative), then they are observed (analyzed) from the attributive and characteristic point of view. For example, one color is obtained by combining two or more colors. In the logistics node, employing a variety of hardware and software input devices are transformed in the composition of the function outputs that will eventually generate decomposition and diversification. Operations (activities) are discretized in the implementation of the types of classes and processes are discretized by column of layers. [8].

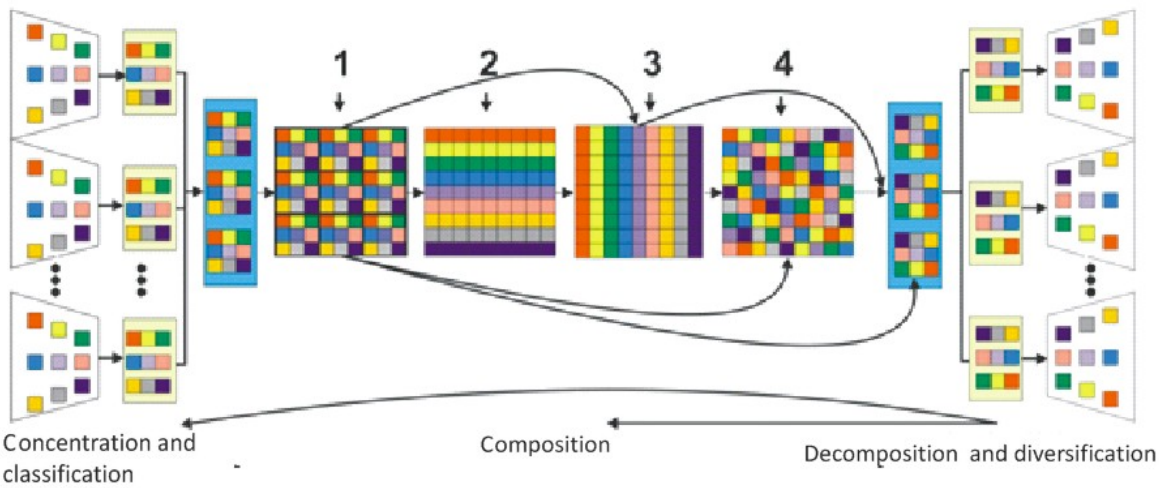


Figure 4. Abstracted compositions of functions of logistics center

The abstraction made in this way, of inputs and outputs, allows the processing of important processes and activities of compositional structure. The function of objectives and the optimization of processes and operations in the system as a logistics center depend on the input classification and the concentration and of the required output for the purpose of later decomposition and diversification.

In the mathematical modeling, the composition of function as the term is most easily explained by Venn diagrams and bijective mapping. [11,12] Injection represents the input and a surjection a logistics center,_and as it only stops the continuous flow of units,_it shows s surjection in order for next surjection -output. Mapping f: A → B is said to be bijective or both unambiguous if and only if it is at the same time, injective and surjective mapping of set A into a set B. For a mapping f : A → B is said to be bijective or unambiguous on both sides if and only if it is the injective mapping of A to the set B.

Thus, every element of B is the image of one and only one element of A.

In this case the transfer functions are the processes and operations that lead to this kind of mapping. It is necessary, therefore, to study the activity and processes (operations), as a function of transmission, Figure 5.

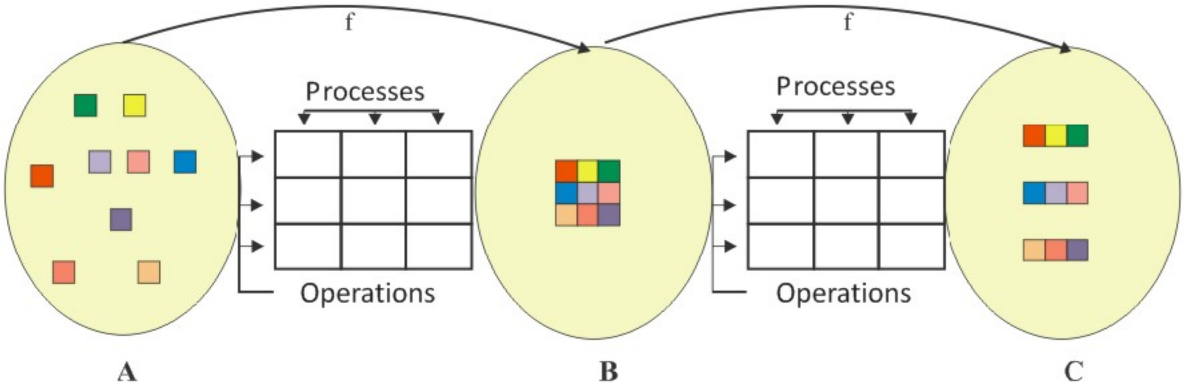


Figure 5. Venn diagrams and mapping activities of processes and operations

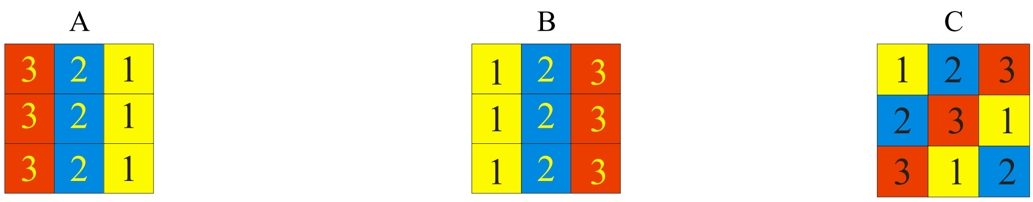
The analogy of the case (logistics center) reminds of generating musical compositions, where the units represent tones; tones are placed in harmony (chords), a combination of harmony on some tact's (criteria) in the composition. Harmonies in short intervals have to change (transform) per tacts, in order to generate a composition. The composition can be performed with a variety of instruments, so the compositions are performed with a variety of orchestras (output elements). The result can be a good composition, but poor orchestra performance, or good composition well performed by the orchestra. Processes and activities to the functioning of the system (logistics center) are consequences of the functional organization of life and work. Theoretical analysis of the processes and activities in the 2D area is described, i.e. quantified and qualified, usually on the discretized sections and activities, because the analysis is easier with a random variable rather than with transitional status and location- change over time (by random processes). Deciding as a control element is performed on the basis of information and data, for example on the basis of information from one course of action or one overview of situation. In this theoretical setting the composition can be analyzed vertically, diagonally, circular, pyramidally and freely.

3.3. Quantification and formalization of structural elements in the function of status and location changes

As previously indicated, the composition of the cargo units on 2d area can have a free (random) and compositional (non-random) schedules. With random arrangement, there is no composition and no technological processes were applied on the units or the operations in terms of logistics to generate compositions.

Let us analyze the flow of units within the node to the exit. For ease of conclusion analyzed are three types of units (different weight) in particular order 3 x 3 and a (micro) flow toward the exit calculated. In Figure 6 presented are three cases: two extreme ones and one balanced. Also, number 1 represents the lowest weight, and number 3, the highest. It is understood that they may have a value of 1.1, 1.2 and 1.3, respectively, and so on.

The requirements for stacking on the output can be also one of the aforementioned sequences. [12] In this case, there are several variants. By comparing the size of invested work that needs to be carried out to convert the initial state to the desired state it is easy to conclude that the extreme differences of the finished work visually appear, as shown in Figure 7.

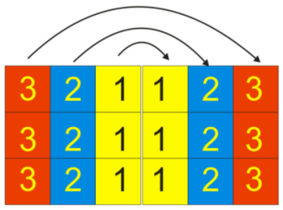


Building block of 3 units in order 3 x 3 from heavier to lighter

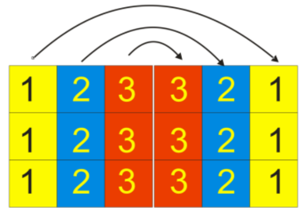
Building block of 3 units in order 3 x 3 from lighter to heavier

Building block of 3 units of balanced order 3 x 3

Figure 6. Building block of 3 units in order 3 x 3



a) The maximum work to establish order from the initial state to the required output



b) Minimum work to establish order from the initial state to the required output

Figure 7: Overview of the work invested to transform the initial state in the given order at the exit

For the purpose of quantification the criterion weight x distance can be used. If the weights are marked with label *qi*, and unit distance with *i* (unit step) to *n-1* steps made, or cells, then the maximum and minimum function of the objective is calculated:

$$F_{\max,\min} = n \cdot \sum_{i=1}^{n} q_i \cdot [n-(2i-1)] \qquad (9)$$

[weight x distance] according to the order of unit weight by types. So, if *qi* is a monotonically decreasing series of the initial state and monotonically increasing in the desired output, we get the maximum objective function (uptime), and if it is monotone increasing in the initial state and monotonically decreasing by desired output, then minimum objective function is obtained. It is obvious that in the translation of system in such a setting there is the mean value of the objective function. Other variations of the ranking of work invested from the initial state to the desired output are within these intervals and they need to be logistically adjusted at the output.

4. BALANCING FEATURES AS A RELEVANT FACTOR OF EFFICIENCY IN LOGISTICS

4.1. Features of balancing units

If we analyze the case of the three units in the order of 3 x 3 in 2D area. [6] With the arrangement by height or weight so that block stacking is balanced in the 2D area (without repetition), it is necessary to proceed as follows. Respectively, the units are labeled with numbers 1, 2, 3 and the matrix (3 x 3) of balanced arrangement is observed. Numbers (scalars) are arranged so that the sum of the columns and types are equal. In this way a regular pattern is obtained, which is called balanced due to properties of equal marginal values (height, weight) in the 2D area. Marginal values of matrix A is in particular case 6, while the marginal value of its inverse gives the reciprocal value of the marginal values of the matrix A. This is shown in Figure 8.

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 3 & 1 \\ 3 & 1 & 2 \end{bmatrix} \begin{matrix} 6 \\ 6 \\ 6 \end{matrix} \qquad \begin{matrix} 6 & 6 & 6 \end{matrix}$$

$$A = \begin{bmatrix} -0,277 & 0,055 & 0,388 \\ 0,055 & 0,388 & -0,277 \\ 0,388 & -0,277 & 0,055 \end{bmatrix} \begin{matrix} 1/6 \\ 1/6 \\ 1/6 \end{matrix} \qquad \begin{matrix} 1/6 & 1/6 & 1/6 \end{matrix}$$

Figure 8: The matrix A and its inverse marginal values

It is argued that any regular balanced matrix i.e., with equal marginal value of column and type has a balanced inverse matrix whose marginal values are equal to the reciprocal marginal values of the original matrix.

Lema. Let $e_1 = (1, 0, ..., 0), ..., e_n = (0,0, ..., 1)$ canonical base and $v = e_1 + ... + e_n$. Then a square matrix A of order *n* has the property that the sum of the elements of each of its type is equal α if and only if $Av = \alpha v$, i.e. if α eigenvalue of matrix A, and v promissory vector.

Proof. Denote with „•" scale product. If $A = (a_{ij})$, then $a_{ij} = Ae \bullet ei$, and the sum of elements of the *i*-type

$$\alpha = \sum_{j=1}^{n} a_{ij} = e_i \cdot \sum_{j=1}^{n} Ae_j = e_i \cdot Av.$$

On the other hand, $\alpha = \alpha v \bullet e_i$, so from the above relation it follows that for all *i* the following applies:

$$e_i \cdot Av = e_i \cdot \alpha v,$$

Where we conclude that Av = a*v*. (End of proof of Lemma.)

Theorem. Let A be a regular matrix with the property that the sum of the elements of each of its Type equals to α, different from zero, and the matrix A^{-1} has the property that the sum of the elements of each of its Type equals to α^{-1}.

From the previous lemma $Av = \alpha v$, and multiplying by A^{-1} we get $v = \alpha A^{-1} v$, or $A^{-1} v = \alpha^{-1} v$. Finally, the assertion is obtained using the previous equality and the opposite direction in Lemma.

This above evidence makes balancing (i. e. the formation of additional equations) much easier when on the 2D surface some elements are fixed, or in determining the number of dependent and independent variables in the process of balancing. It should be noted that in logistics there are two types of balancing weight (height, etc.) in 2D area - block stacking and freestyle stacking. Therefore, it is necessary to analyze the quadratic form of stacking. If the number of blocks is marked with x, the number of units of different sizes with n and matrix that needs to be balanced with M_{nxn}, then the block-type of stacking of a square matrix with the aim of balancing implies $x = n^{1/2}$ blocks per type, $x = n^{1/2}$ blocks per column (where the roots are positive integers greater than 2) whereby the number of blocks in the matrix is equal to the number of different units. Thus, a square matrix M_{nxn} has n^2 cells, n different layers (rows and columns), and $x^2 = n$ blocks. The number of blocks and the various units within the matrix is, respectively: 4, 9, 16, ... or x^2 . In order to analyze in the static and dynamic sense, one block and one free way of stacking in equilibrium is shown in Figure 9 (a and b). As shown in Figure 9, the sizes are balanced by looking at the marginal totals. Since this is a regular pattern its inverse patterns are shown in Figure 10. It is observed that the sum of the inverted sizes are arranged in the block stacking sums of inverted size, by the blocks, equal to each other and also equal to the reciprocal value of the marginal values of the inverse matrix (1/45), but not for each block complex matrix. So, with block stacking to balance the sum of the blocks it is equal to the sum of the marginal values of the matrix, which is not the case for the free stacking for balance purposes.

9	6	8	7	1	4	5	3	2
5	2	4	8	3	6	1	7	9
1	3	7	2	5	9	6	4	8
3	4	5	1	2	8	7	9	6
6	7	1	9	4	3	2	8	5
2	8	9	6	7	5	4	1	3
4	9	2	3	6	7	8	5	1
8	5	6	4	9	1	3	2	7
7	1	3	5	8	2	9	6	4

a) Balanced „block" stacking by sudoku principle

1	2	3	7	8	9	4	5	6
2	3	4	5	6	7	8	9	1
3	4	5	6	7	8	9	1	2
4	5	6	1	2	3	7	8	9
5	6	7	8	9	1	2	3	4
6	7	8	9	1	2	3	4	5
7	8	9	4	5	6	1	2	3
8	9	1	2	3	4	5	6	7
9	1	2	3	4	5	6	7	8

b) Balanced free stacking

Figure 9. Two types of balancing of the matrix 9 x 9

0,0433	0,18882	-0,1767	0,0212	-0,1982	-0,056	0,13579	0,08924	-0,0252
0,04209	-0,2538	0,19083	-0,0342	0,24716	-0,0626	-0,0541	0,03254	-0,0856
-0,0076	0,07537	-0,1773	0,14917	-0,1326	0,1578	-0,063	0,01055	0,0098
0,04455	-0,0482	0,13307	-0,1392	0,13733	0,00731	-0,0609	-0,1084	0,05664
-0,1443	0,2726	-0,3002	0,06866	-0,2667	0,14752	0,1449	0,0573	0,04239
-0,037	0,36722	-0,2129	0,00233	-0,3304	0,03745	0,24839	-0,013	-0,0398
0,11457	-0,3984	0,42868	-0,1446	0,33231	-0,1528	-0,1533	-0,0795	0,07525
-0,1072	0,17134	-0,3325	0,24311	-0,1392	0,14532	0,01155	0,001	0,02886
0,07378	-0,3527	0,46927	-0,1442	0,37263	-0,2018	-0,1872	0,03247	-0,0401

The inverse of the original matrix a)

-0,0716	0,00247	0,00247	-0,0716	0,00247	0,00247	0,03951	0,00247	0,11358	0,0222
0,00247	0,00247	0,00247	0,00247	0,00247	0,00247	0,00247	0,11358	-0,1086	0,0222
-0,0346	0,00247	0,00247	0,07654	0,00247	0,00247	0,07654	-0,1086	0,00247	0,0222
0,03951	0,00247	0,00247	-0,0716	0,00247	0,11358	-0,0716	0,00247	0,00247	0,0222
0,00247	0,00247	0,00247	0,00247	0,11358	-0,1086	0,00247	0,00247	0,00247	0,0222
0,07654	0,00247	0,00247	-0,0346	-0,1086	0,00247	0,07654	0,00247	0,00247	0,0222
-0,0716	0,00247	0,11358	0,03951	0,00247	0,00247	-0,0716	0,00247	0,00247	0,0222
0,00247	0,11358	-0,1086	0,00247	0,00247	0,00247	0,00247	0,00247	0,00247	0,0222
0,07654	-0,1086	0,00247	0,07654	0,00247	0,00247	-0,0346	0,00247	0,00247	0,0222
0,0222	0,0222	0,0222	0,0222	0,0222	0,0222	0,0222	0,0222	0,0222	

The inverse of the original matrix b)

Figure 10. The inverse of the original matrix a) and b)

4.2. Influence of different elements balanced in static and dynamic sense − cycle through trajectory

As far as multimodal transport is concerned i.e. during stacking containers on ships, cargo in wagons and road vehicles, it is known that one must take into account that cargo has to be uniformly distributed. In a dynamic sense if you compare the two cases and assume that the values of the cells of the matrix have a certain weight, with a footprint of unit area in 2D space. Also, the assumption is that it is a mobile unit on which the goods are loaded according to the order of weights shown in the matrix (palletized goods in a wagon, road vehicle or container on board). For ease of inspection in Figure 11, graphically displayed is a mobile object that moves along the displayed trajectory. The sum of the coefficient of moments of inertia of the columns is shown in the graphs in Figure 12. For better illustration, the minimum value $r_i = 501$ is selected (distance of center of gravity of the first kind to the center of rotation), with increments between adjacent gravity being 1, so the center of gravity of the last piece is away from the center of rotation $r_i = 509$.

Moments of inertia are given with the form:

$$I = \sum_{i=1}^{N} m_i r_i^2$$

It was assumed that this is a system of independent finite element where the weight is evenly distributed per unit area, their weight is in the middle (at the intersection of the diagonals of unit area) and taking into account that:

$$\lim_{x \to 0} \frac{\sin x}{x} = 1$$

it is easy to conclude that the center of gravity of the types are equally distant from the center of the circular movement of the trajectory given that the square of the radius of rotation is much larger than the radius and growth (the distance between the balanced units).

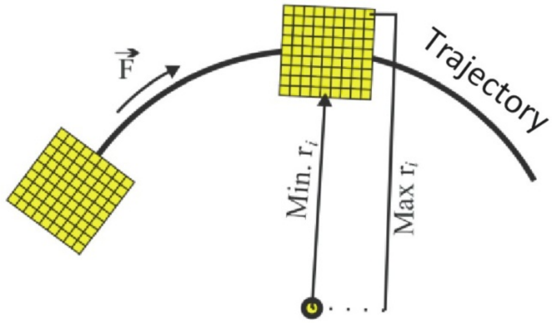


Figure 11. movement of the mobile object on trajectory

In static terms, in Figure 12, for two different types of balanced complex units from Figure, 9 the distribution of the centers of gravity by rows and columns is shown.

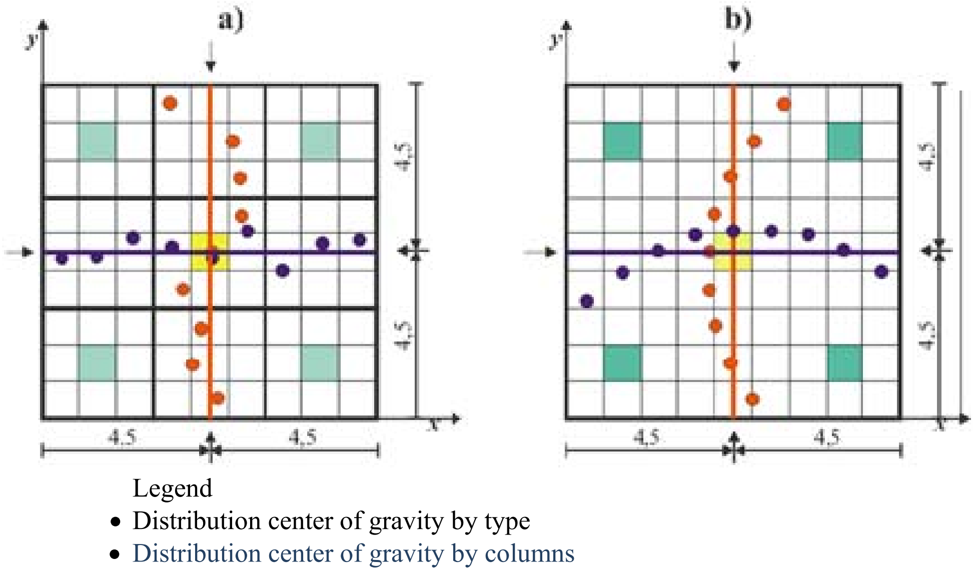


Figure 12. Moments of inertia

The standard deviation of the center of gravity of the mean values by „block“ of complex units is smaller than the free-balanced units. In dynamic terms, in these conditions, that is effected by approximation values of moments of inertia *I* are calculated for two variants of a balanced system, and shown in Figure 13.

Also, as in the static sense, the circular movement of the trajectory, in the dynamic sense the standard deviations are higher in free-balanced unit. It is clear that the best balance in dynamic terms is achieved by the constants inertial moment of columns, so that the heaviest units are positioned in the middle (for balance of centrifugal and centripetal forces) that by columns monotonically decreases towards the end. However, in practice this is sometimes not feasible. In terms of the dynamic process of balancing it is very important and interesting. If cargo stacking is simultaneously observed (containers on the ship, pallets cargo on train, vehicle) to obtain the stability of movement in the direction and curves, the influence of wind, bumps, etc., if not properly balanced it leads to accidents. In this regard, one can imagine which damage can occur by imbalance of containers on board with 9000 containers or train of 1500 tons of gross weight.

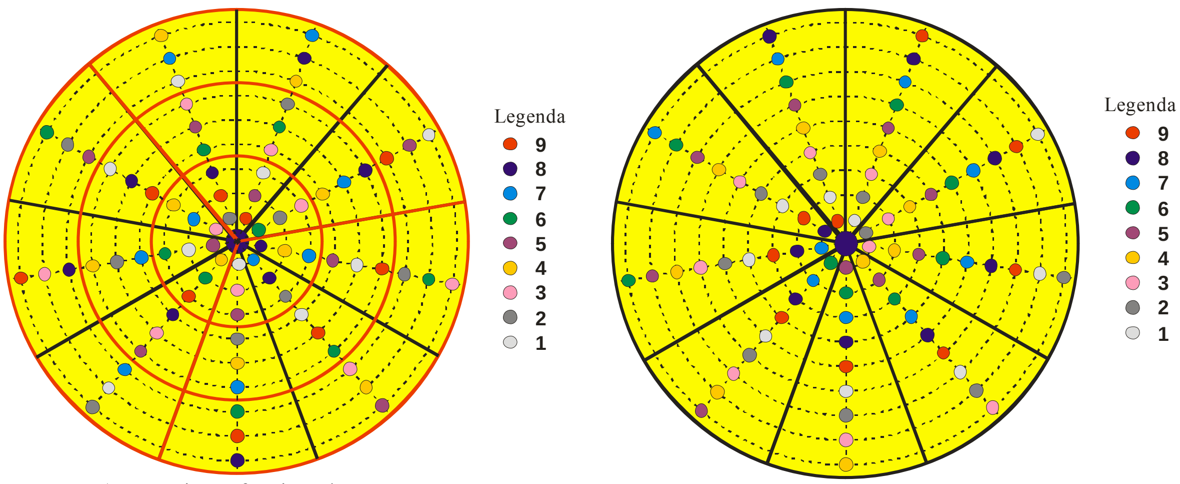
The distribution of moments of inertia of the columns in the block complex unit

The distribution of moments of inertia of the columns in complex units in the free layout.

Figure 13. Sums ratio of moments of inertia by columns

4.3. Influence of differently balanced elements in a dynamic sense-central rotation

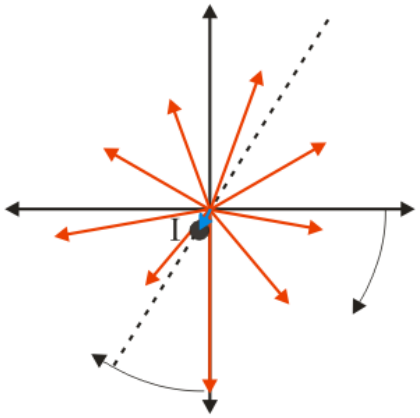
Analyzed is the case during the injected materials of different specific weight and unit volume in the material of a disc shape. Injected were block balanced units and free-balanced units in identical orbits as well as the repercussions when centrifuging the disk. The block of a complex balanced unit is separated by red lines in Figure 14 a), while in 14 b) there are freely balanced units. Results of inertia moments (a vector position), in a number of experiments have shown that block matching of balanced units is better in both the static and dynamic sense. For the purpose of total balance, interventions are less complicated for block units.



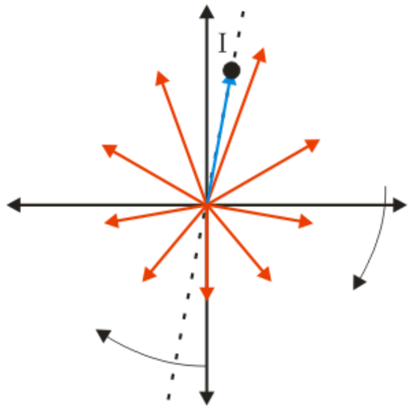
a) Insertion of unit volume, by the „block” principle stacking

b) Insertion of unit volume, by freely principle stacking

Figure 14. Injected (incorporated) balanced composite materials of unit volume and different specific weight



a) The resultant moment of inertia *I*, the intensity and direction of the action (block-balanced units)



a) The resultant moment of inertia *I*, the intensity and direction of the action (free-balanced units)

Figure 15. inertial moments of composite materials in unit volume and different specific weight

5. CONCLUSION

Optimum solutions for the given objective function are found by formalization, introduction of variables, constraints and criteria with appropriate algorithms. However, the optimal solution with respect to the set criteria logistically are quite difficult to find to meet the requirements of equilibrium processes and operations, which are expected to improve in the post optimization if one wants to achieve a high level of efficiency. Since there is a functional relationship of processes and operations, where operations are considered as layers, and processes as discretization (cross-sections) of status and location changes in time and space, we conclude that the balance in the composition of processes and operations makes a significant contribution to post optimization procedure. They are solved afterwards and contribute to greater efficiency and effectiveness in logistics.

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РЕЛЕВАНТНИ ФАКТОРИ ЗА ПОБОЉШАЊЕ ЛОГИСТИЧКИХ ПЕРФОРМАНСИ У ЛАНЦИМА СНАБДИЈЕВАЊА

Абстракт: У раду се анализирају три важна елемента за побољшање логистичких перформанси у ланцима снабдијевања. Прва важна компонента за ланце снабдијевања односи се на редукцију саобраћајних, комуникационих и кореспондентних линија, друга се односи на процесе уравнотежења по слојевима активности и трећа на микропроцесе различито уравнотежених стања јединица у циљу генерисања најбољих композиција. Фактори у управљачком смислу су стратешког, тактичког и оперативног нивоа, чија примјена повећава ефективност и ефикасност логистичких система. У раду се придаје значај факторима ефикасности у логистичким центрима, односно процесима и операцијама у функцији композиционих уравнотежења статусних и локационих промјена теретних јединица.

Кључне ријечи: управљање ланцима снабдијевања, процеси и операције, композиција, уравнотежење.