UDC 338.2
DOI: 10.15587/2312-8372.2017.112514

Lutsenko I., Fomovskaya E.

DEVELOPMENT OF THE METHOD FOR FORMATION OF THE SYSTEMALLY BASED LEVEL OF RESOURCES OF LOGISTICS OPERATIONS

Виробнича або торгова діяльність завжди пов'язана з необхідністю дослідження і формування параметрів логістичних операцій. Незважаючи на тривалу історію і велику кількість проведених досліджень в даний час відсутні системно обґрунтовані методи визначення оптимальних параметрів логістичних операцій. Запропонований похід забезпечує можливість створення моделі логістичної операції і визначення системно обґрунтованого рівня страхових запасів.

Ключові слова: *логістична операція, модель логістичної операції, страховий запас логістичної операції.*

1. Introduction

Maximization of the economic capabilities of the owner of financial resources requires the optimization of the processes of controlled systems under his control. In this case, the more degrees of freedom control systems have, the higher their optimization capabilities and, the higher, maybe, their return.

It is established that the maximum number of degrees of freedom for controlled structures can be obtained only if the system function of forming the qualitative parameters of the main product is separated from the system function of forming the required quantitative parameters of the finished product (Fig. 1) [1, 2].

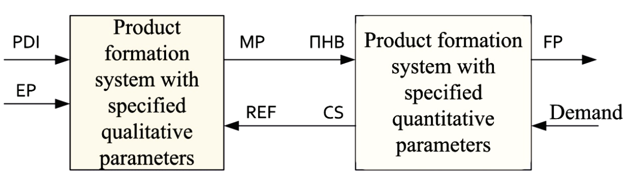


Fig. 1. Industrial structure, within which qualitative and quantitative parameters of finished products are formed in the framework of individual systems: PDI – the product of directed influence; EP – energy product; MP – main product; REF – reference signal; CS – control signal; FP – finished product

To obtain a product at the output of a controlled system with a given qualitative parameter, extraction systems, conversion systems and displacement systems are used. Let's define this class of systems as active systems.

A distinctive feature of active systems is that their basic technological function is carried out with an explicit use, generation or allocation of an energy product.

Products with specified quantitative parameters can be obtained at the output of buffering systems [2]. The basic technological mechanism of the buffering system is a technical integrator (bunker, storage, capacity, etc.).

The buffering system, if necessary, starts the active system in order to replenish the stocks with a quality product or transfers it to the stage of passive waiting.

The demand parameters and the parameters of the technological process of the active system have a significant influence on the choice of the value of the lower and upper level of the buffering system reserves in the optimization process. In turn, increasing the upper level of the buffering system's resources reduces the start-up losses of the active system, but it increases the amount of related resources.

This leads to the need to consider the operational processes of the active system and the buffering system (Fig. 1), as the processes of a single, integrated system that solves the two-fold problem of forming a finished product with specified qualitative and quantitative parameters.

Let's define such system by the term «executive system» (ES).

Given that the solution of the task of optimizing the operational processes of the executive system is required within the framework of any industrial structure, the definition of a systemically sound ES level of reserves is an important scientific task.

2. The object of research and its technological audit

The object of research is the model of the logistics operation process. The peculiarity of the logistics model under consideration is the possibility of taking into account all the significant factors that influence the evaluation of its effectiveness. So, the model is sensitive to the parameters of the product of the active system load, the time of its functioning and the amount of power consumption. Also, the degree of consistency of outputs and the level of demand for these products is taken into account.

The possibility of evaluating the efficiency of logistics operations is ensured by reducing its input and output products to comparable value values.

The main disadvantage of using this model is the need for special studies related to determining the marketing value of the product of the logistics operation for the correct determination of the penalty function value.

3. The aim and objectives of research

The aim of research is determination of the method for effectiveness evaluation of ES operation.

To achieve the aim, the following tasks are set:

1. Determination of ES operation model.
2. Determination of the optimization criterion for ES operation models.
3. Development of a method for determining the systemically sound level of the insurance stock of ES logistics operation.

4. Research of existing solutions of the problem

One of the first works, which was aimed at determining the ES optimal parameters, was presented in 1913. Its result was the creation of a formula known as the Wilson formula. Advantages [3] and disadvantages [4] of this work are still actively discussed [5].

In fact, the task of determining the effectiveness of the ES operation should be addressed within the discipline, which is defined as «operation research» [6]. However, within the framework of this direction, methods of solving a number of particular problems began to develop actively [7]. So far, within this discipline, such basic concepts as «operation» [8] and «operation model» [9] have not been defined.

The most urgent task of assessing the ES effectiveness operations [10] is raised in those cases where the cost issues [11], speed [12] and the time of production [13], within the material flows, were clearly linked with the need to take into account the nature of demand [14] and consequences of a possible shortage of products [15].

The need for an interrelated study of the operational processes of the movement of material flows of several systems led to the creation of the concept of «logistics» and «logistics operation».

In the works devoted to the optimization of the processes of coupled systems, certain aspects of formation of the logistics operation parameters [16] are considered, in particular, the systemically justified value of the insurance stock. Although the size of the insurance stock must take into account the probability of a deficit, product profitability and the number of buyers, statistical methods are used to determine it, which these factors do not take into account by definition [17].

Thus, the question of determining the systemically justified value of the insurance stock, which allows to take into account all the relevant factors, is not resolved for today.

5. Methods of research

During the research, methods of system analysis, operations research and parametric optimization are used.

6. Research results

6.1. Construction of the logistics operation model. The main requirement, which is shown to the quality of management of any operational process, is its maximum efficiency.

Since the expression for determining the efficiency relates the given input function and the reduced output function, it would seem necessary to select the ratio between the input and output function for which maximum efficiency is achieved to achieve maximum efficiency.

In practice, the search for management, which corresponds to maximum efficiency, is significantly hampered by the availability of a probabilistic nature of the demand for finished ES products.

This fact imposes certain restrictions on the management process and additional conditions under which the maximum of efficiency can be considered as achieved.

This is due to the fact that supply disruptions (product shortages) lead to undesirable consequences, which are manifested in increasing technological costs or/and lowering the level of demand for ES products and related systems.

As a consequence, the production deficit at the output of the buffering system (BS) leads to a decrease in the efficiency of the logistics operation (LO).

In order for the ES operation to be as efficient as possible, the sequence of operations is sought to be managed in such way that each subsequent batch of active system products enter the buffering system at the time when its stocks are not zero.

The level of reserves with which at the time of the next planned replenishment seek to compensate for a possible deficit, as a possible consequence of the probabilistic nature of demand, is defined by the concept of «insurance stock».

On the other hand, unjustified increase of the insurance stock also leads to a decrease in the efficiency of the logistics operation [18].

Thus, to solve the problem associated with the evaluation of the efficiency of a logistics operation, it is first and foremost necessary to determine the operation model, which, depending on demand, takes into account both the possibility of forming an insurance stock and the shortage of finished products.

The next ES operation begins at the moment when the level of the buffering system's resources reaches a certain lower level. At this point in time, taking into account anticipation, a control signal is generated from the buffering system, which is the reference signal for the active system.

The BS reference signal is formed taking into account the delay time necessary for performing the technological function of the active system and taking into account the probabilistic nature of the demand.

Depending on the management method, the forecast of the future level of reserves is used either to determine when the next operation has started, or to determine the level of the order [19]:

$$REST_F = REST_S - PRG_{ID} \cdot T_A,$$

where PRG_{ID} – the level of forecasted demand reduced to a single sampling interval; T_A – active system operation time; $REST_S$ – the current level of BS stock at the time of the management formation; $REST_F$ – the current level of BS stock at the time of the commencement of the next operation.

Let's consider the principle of constructing the LO model using the ES example, whose active system is the displacement system. In this case, the quantitative parameters of the displacement product at the input of the active system correspond to the quantitative parameters of its output product, which simplifies the process of visualization of the operation model.

 ISSN 2226-3780

Let's suppose that the function of demand $sq(t)$ for ES finished product is of a stationary nature (Fig. 2). Then the level of reserves of the buffering system of the previous operation $rest_{pr}(t)$ will decrease linearly.

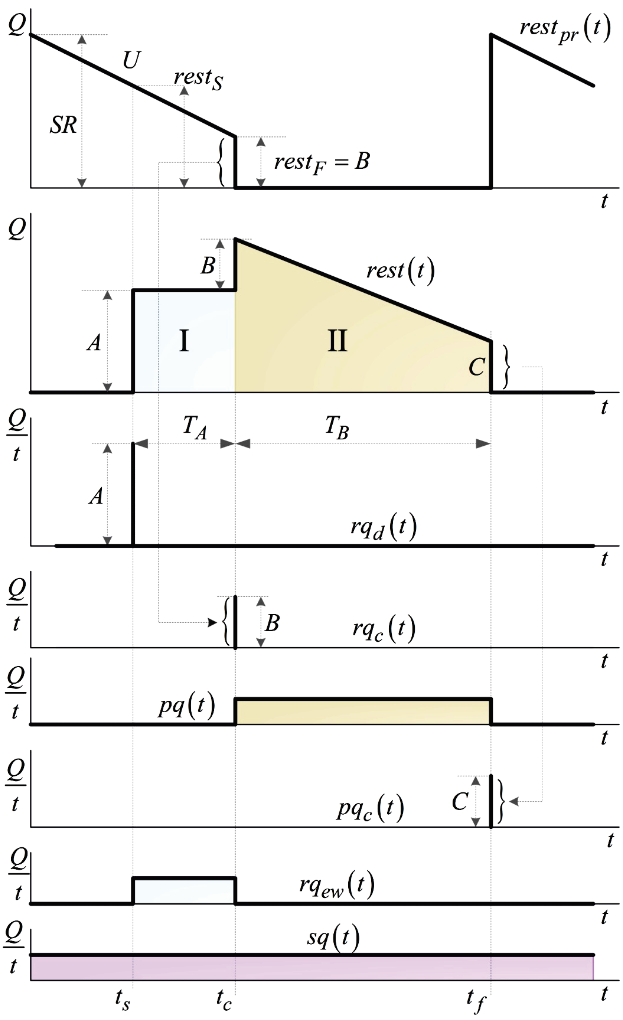


Fig. 2. The model of logistics operation in conditions, when the level of demand is less than its predicted value: t_s – the beginning moment of the logistics operation; t_c – the moment of interaction of the active system and the buffering system; t_f – the time of completion of the logistics operation

At the moment t_s, the buffering system generates a reference signal for the active system. The formation of this signal is carried out taking into account that the operation of moving the product by the A value of the active system is completed at the time when the buffering system reserves have a nonzero value $rest_{pr}(t) = rest_F = B$. The process of moving the products of the active system is ensured by the supply of an energy product $rq_{ew}(t)$.

Accordingly, the moment of time t_s is the beginning moment of the operation.

Let's suppose that begin of a subsequent operation should begin at the point at which the next replenishment of stocks will occur at the time t_c. Then a in the buffering system, according to the forecast, there should remain a part of the reserves of B. This stock is determined by the concept of «insurance stock».

Thus, the moment t_s is characterized by the fact that at this point in time the product of displacement arrives at the input of the active system. From the moment t_s the input of the active system also receives an energy product, which provides the movement process.

At the moment t_c, the transfer process ends, and the conditionally transferred remainder of the buffering mechanism from the previous operation arrives at the input of the operation under investigation.

In the interval from before t_c to t_f at the output of the operation, the output of the logistics operation is formed in the form of a function $pq(t)$ that corresponds to the demand function on this time interval.

At the time t_f the investigated operation interrupts the active phase of the next operation. In this case, the balance of stocks by the value C is conditionally transferred to the input of the next operation.

To calculate the efficiency of the logistics operation model, it is necessary to determine the resulted output function $pe(t)$ and the reduced input function $re(t)$.

Given the model (Fig. 2):

$$pe(t) = pq(t) \cdot ps + pq_c(t) rs_d,$$

where $pq(t)$ – the function of registering the finished products of the logistics operation; ps – cost of the finished product of the logistics operation; $pq_c(t)$ – the function of registering the volume of the conditionally transferred batch of products of the buffering system; rs – the cost of a unit of input directed product.

On the other hand:

$$re(t) = rq(t) \cdot rs + rq_c(t) rs + rq_e(t) rs_e + rq_t(t) rs_t,$$

where $rq(t)$ – the function of registering the directional product; $rq_c(t)$ – the function of registering the conditionally transfer of the product of the buffering system; $rq_e(t)$ – function of registering the flow of energy costs of an active system operation; rs_e – valuation of energy product unit; $rq_t(t)$ – function of registration of the system equipment deterioration; rs_t – valuation of a deterioration unit.

The logistics operation model (Fig. 2) can be defined as a surplus operation. This is due to the fact that upon completion of the operation, the ballast stocks of the finished products remain in the buffering system.

A different picture is observed in those cases when the level of demand for finished products $sq(t)$, after the start of a logistics operation, increases (Fig. 3).

In this case, the level of the buffering system's reserves may drop to zero before the next operation begins. Such operations are defined by the concept of «deficit operations».

The reduced function of the deficit operation can be determined by the expression:

$$pe(t) = pq(t) \cdot ps + k \cdot fq(t) \cdot \frac{AE}{T_B},$$

where AE – the operation profit; T_B – the interval of the satisfied operation demand; k – penalty coefficient for deficit.

Thus, the LO model has its own characteristic features (Fig. 4). The model must take into account the movement of the associated products of directional impact, the movement associated with the delivery of the finished product, power consumption and wear, it is also necessary to determine the value of the input conditionally transferred lot of products.

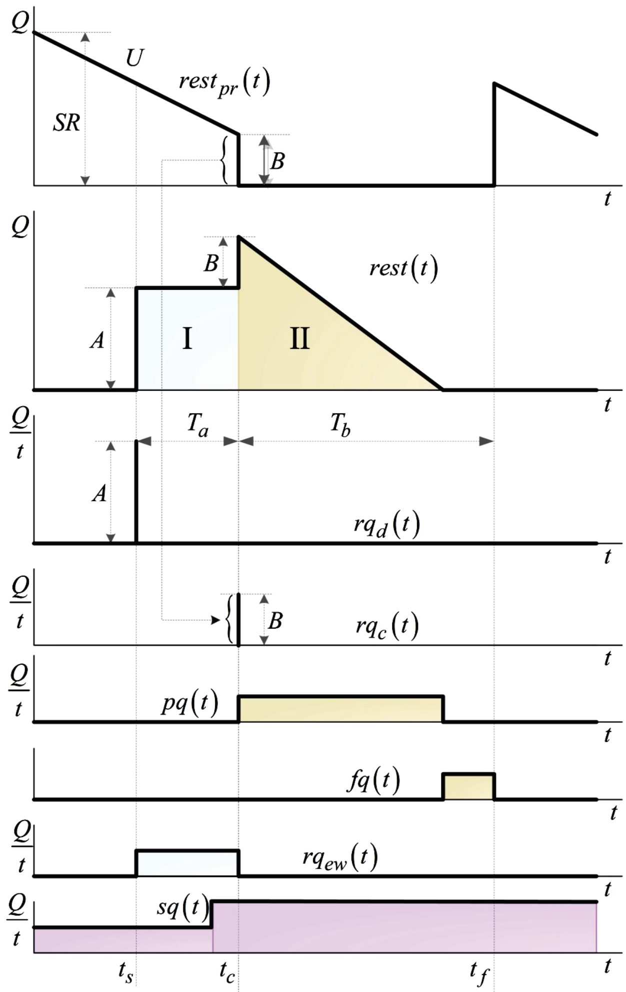


Fig. 3. Model of logistic operation in conditions, when the level of demand is greater than its predicted value: t_s – the beginning moment of the logistics operation; t_c – the moment of interaction of the active system and the buffering system; t_f – the time of completion of the logistics operation

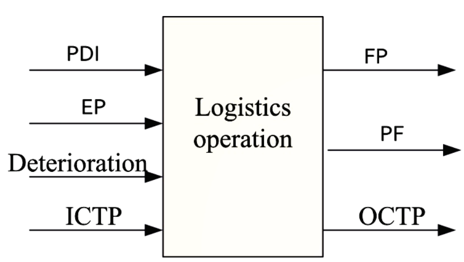


Fig. 4. Logistics operation model: PDI – the product of directed influence; EP – energy product; ICTP – input conditionally transferred product; FP – finished product; PF – penalty function; OCTP – output conditionally transferred product

In addition, depending on the change in the demand level, the output parameters of the model change, which manifest themselves in changing the parameters of the fine function for a product deficit or in changing the parameters of the output conditionally transferred products.

In turn, the transition to the definition of reduced input and output functions, in order to evaluate the LO effectiveness, requires consideration of the cost estimates of its input and output products.

6.2. Determination of logistics operation efficiency. Determination of the LO model and calculation of its efficiency will be considered using the example of the conditional logistics process.

If the moments of transfer of products from the supplier to the product moving object, from the transfer object to the enterprise and from the enterprise to the buyer are displayed in the form of time series, then the logistic process model can be displayed in the form of time series (Fig. 5).

n	rq_1^*	rq_2^*	$rest^*$	pq^*	sq^*
0					
1	10		0		
2			0		
3			0		
4		10	9	1	1
5			8	1	1
6			7	1	1
7	10		6	1	1
8			5	1	1
9			4	1	1
10		10	13	1	1
11			12	1	1
12			11	1	1
13			10	1	1
14			9	1	1
15			8	1	1
16			7	1	1
17	10		6	1	1
18			5	1	1
19			4	1	1
20		10	13	1	1
21			12	1	1
22			11	1	1
23			10	1	1
24			9	1	1
25			8	1	1

Fig. 5. Time series of movement of products within the executive system: $rq_1^*[n]$ – registration of output production volumes; $rq_2^*[n]$ – registration of input production volumes; $pq^*[n]$ – registration of production volumes transferred to the consumer; $sq^*[n]$ – demand function

The current level of the company's reserves can be displayed using a recurrence expression:

$$rest^*[n]=rq_2^*[n]+rest^*[n-1]-pq^*[n].$$

In general, the moment when a new logistics operation begins, one can consider the moment when the batch of the product intended for the organization of the trading process has left the supply source. These are moments of time 1, 7, 17 of the $rq_1^*[n]$ series.

For definiteness, let's consider a trading operation that begins within the sampling interval $n=7$. At this interval, the product is registered at the output of the delivery enterprise. Within the interval $n=10$, the product is delivered by the carrier, enters the warehouse entrance and interrupts the course of the current operation.

Accordingly, the remainder of the stocks, which was at the time of receipt of a new batch of products, is considered conditionally transferred to the production log of the logistic operation being investigated.

From this point in time, and until the next batch of products arrives at the entrance of the trading enterprise ($n=13$), each unit of sales relates to the investigated logistics operation.

ISSN 2226-3780

At the sampling interval $n=12$, the operation conditionally transfers the next operation to 4 units of the products that have not been sold before its completion.

Thus, the product model of a logistics operation can be characterized by functions that reflect the process of registering input and output products of a logistics operation (Fig. 6).

n	rq_1^*	rq_2^*	$rest^*$	pq*	gq*	rq_D	rq_C	rest	pq	pq_C
0					1					
1	10		0		1					
2			0		1					
3			0		1					
4		10	9	1	1					
5			8	1	1					
6			7	1	1					
7	10		6	1	1	10		10		
8			5	1	1			10		
9			4	1	1			10		
10		10	13	1	1		4	13	1	
11			12	1	1			12	1	
12			11	1	1			11	1	
13			10	1	1			10	1	
14			9	1	1			9	1	
15			8	1	1			8	1	
16			7	1	1			7	1	
17	10		6	1	1			6	1	
18			5	1	1			5	1	
19			4	1	1			4	1	4
20		10	13	1	1					
21			12	1	1					
22			11	1	1					
23			10	1	1					
24			9	1	1					
25			8	1	1					

Fig. 6. Allocation of logistic operation model within the logistics process: $rq_D[n]$ – the input product of the active system; $rq_C[n]$ – the input conditionally transmitted product of the buffering system; $rest[n]$ – the current stocks of the operation; $pq[n]$ – the flow of sold products; $pq_C[n]$ – registration of the batch of conditionally transferred products

A convenient visualization of the logistics operation model is the function of reserve change $rest[n]$, which is determined using a recurrence expression (Fig. 7):

$$rest[n]=rq1[n]+rest[n-1]-pq[n].$$

Since the level of demand in open systems is of a probabilistic nature, the logistic operation model can display three outcomes that can be expressed using the concepts of «surplus operation» (Fig. 7), «coordinated operation» (Fig. 8, *a*) and «deficit operation» (Fig. 8, *b*).

The function of unmet demand is determined by the expression:

$$fq[n]=\begin{cases} pq[n]-rest[n], \; pq[n]>rest[n], \\ dq[n], rest[n]=0. \end{cases}$$

For example, if the demand level of the operation (Fig. 6) within the interval changed and became equal to 1.5, the surplus operation would change to a deficit operation (Fig. 9).

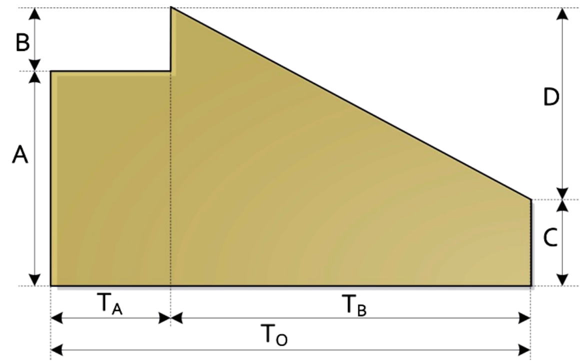
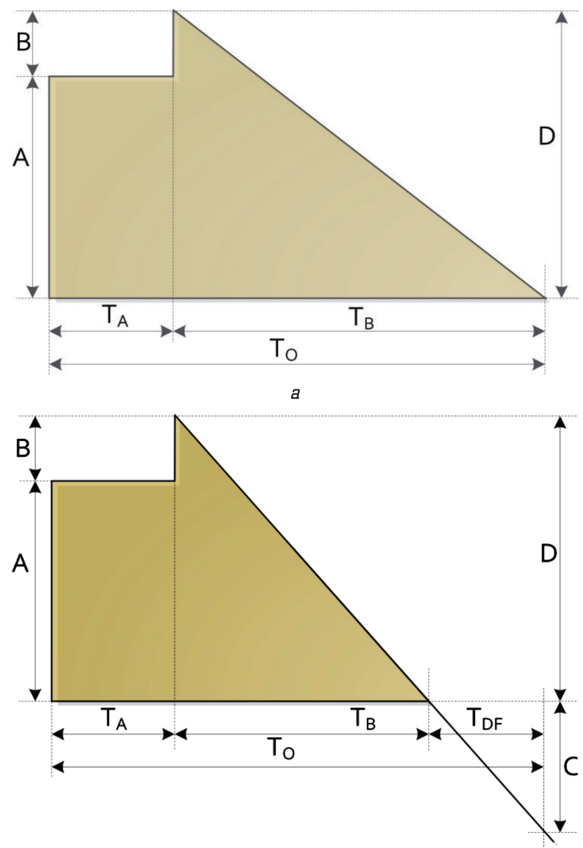


Fig. 7. The model of redundant logistics operation in the form of a stock change function: *A* – the volume of input of the active system; *B* – the input conditionally transferred volume of production; *C* – the output conditionally transferred volume of production; *D* – the volume of sales; T_A – the time of the active system operation; T_B – the time of the buffering operation; T_O – the time of logistics operation



a

b

Fig. 8. Models of coordinated and deficit logistics operations in the form of a stock change function: *a* – coordinated operation; *b* – deficit operation: *C* – level of unmet demand; T_{DF} – deficit time

It is established [20] that any operation can be represented as a pair ($re(t)$, $pe(t)$) or, in the case of a discrete transformation, as pair of functions ($re[n]$, $pe[n]$).

Let the unit cost of a unit of input product is $rs=2$ money units, and the unit value of the output unit is $ps=3$ money units

Then, the functions $rq_D[n]$ and $rq_C[n]$ can be reduced to the form $re[n]$ by reducing the quantitative parameters of the function $rq_D[n]$ and $rq_C[n]$ to comparable cost values. Adding functions in time, obtain:

$$re[n]=rq_D[n]\cdot rs+rq_C[n]\cdot rs.$$

n	rq_D	rq_C	rest	pq	pq_C	sq	fq	re	pe	fe	ife	ire	ipe	vre	vpe	dif	r
0																	
1	10		10					20				20	0	0	0	0	0
2			10									20	0	20	0	20	20
3			10									20	0	40	0	40	60
4		4	13	1.5		1.5		8	6			28	6	60	0	60	120
5			11	1.5		1.5			6			28	12	88	6	82	202
6			9.5	1.5		1.5			6			28	18	116	18	98	300
7			8	1.5		1.5			6			28	24	144	36	108	408
8			6.5	1.5		1.5			6			28	30	172	60	112	520
9			5	1.5		1.5			6			28	36	200	90	110	630
10			3.5	1.5		1.5			6			28	42	228	126	102	732
11			2	1.5		1.5			6			28	48	256	168	88	820
12			0.5	0.5		1.5	1		2	4	4	28	50	284	216	68	888
13			0		0	1.5	1.5			6	10	28	50	312	266	46	934
14											10	28	50	340	316	24	958
15											10	28	50	368	366	2	960
16											10	28	50	396	416	–20	940

Fig. 9. The model of a deficit operation and an example of formation of calculation functions for determining effectiveness: *sq*[*n*] – demand; *fq*[*n*] – unmet demand; *fe*[*n*] – reduced function of unmet demand; *ife*[*n*] – the current value of the unmet demand; *ire*[*n*] – the current value of resource consumption; *ipe*[*n*] – the current value of resource return; *vre*[*n*] – the integral value of resource consumption; *vpe*[*n*] – the integral value of the resource return; *dif*[*n*] – the value of resource consumption and resource return mismatch; *r*[*n*] – the current value of the resource-intensive operation

In turn, the functions $pq_S[n]$, $pq_C[n]$ and $fq[n]$ can be transformed to the form $pe[n]$:

$$re[n]=rq_D[n]\cdot rs+rq_C[n]\cdot rs.$$

Since the conditionally transferred batch of the output product is not sold to the buyer, it is multiplied by the valuation of the unit of the input product.

In general, to evaluate the effectiveness, it is possible to use the ELF (1) indicator, which went through the verification stages for consistency of the efficiency concept [21, 22]:

$$ELF=\frac{\int\limits_{t_a}^{t_d}\left(\int\limits_{t_a}^{t}\left[\int\limits_{t_0}^{t}pe(t)\mathrm{d}t-\int\limits_{t_0}^{t}|re(t)|\mathrm{d}t\right]\mathrm{d}t\right)\mathrm{d}t}{\int\limits_{t_0}^{t_a}\left[\int\limits_{t_0}^{t}\left(\int\limits_{t_0}^{t}|re(t)|\mathrm{d}t\right)\mathrm{d}t-\int\limits_{t_0}^{t}\left(\int\limits_{t_0}^{t}pe(t)\mathrm{d}t\right)\mathrm{d}t\right]\mathrm{d}t},$$

$$t\in[0,\ t_a], \tag{1}$$

where t_a – the moment of actual completion of the operation time, which is determined at the time of equality of the functional expressions:

$$\int\limits_{t_0}^{t}\left(\int\limits_{t_0}^{t}pe(t)\mathrm{d}t\right)\mathrm{d}t=\int\limits_{t_0}^{t}\left(\int\limits_{t_0}^{t}|re(t)|\mathrm{d}t\right)\mathrm{d}t,$$

$t_d=t_a+1$ – the completion time of the determination of the potential effect of the operation.

Let's introduce the notation:

$$ire(t)=\int\limits_0^t re(t)\mathrm{d}t \text{ and } ipe(t)=\int\limits_0^t pe(t)\mathrm{d}t.$$

Then the discrete functions $ire[n]$ and $ipe[n]$ can be defined by presenting them in the form of recurrence expressions (Fig. 10):

$$ire[n]=ire[n]+re[n]+ire[n-1],$$

$$ipe[n]=ipe[n]+pe[n]+ipe[n-1].$$

Let's introduce the notation:

$$vre(t)=\int\limits_0^t\left(\int\limits_0^t re(t)\mathrm{d}t\right)\mathrm{d}t=$$

$$=\int\limits_0^t ire(t)\mathrm{d}t,$$

and

$$vpe(t)=\int\limits_0^t\left(\int\limits_0^t pe(t)\mathrm{d}t\right)\mathrm{d}t=$$

$$=\int\limits_0^t ipe(t)\mathrm{d}t.$$

Then for discrete functions in the recursive form:

$$vre[n]=vre[n]+ire[n-1]+vre[n-1],$$

$$vpe[n]=vpe[\mathrm{n}]+ipe[n-1]+vpe[n-1].$$

Let's define the function dif as the difference $dif=vre[n]-vpe[n]$ on the interval, where $vre[n]>=vpe[n]$ (Fig. 11).

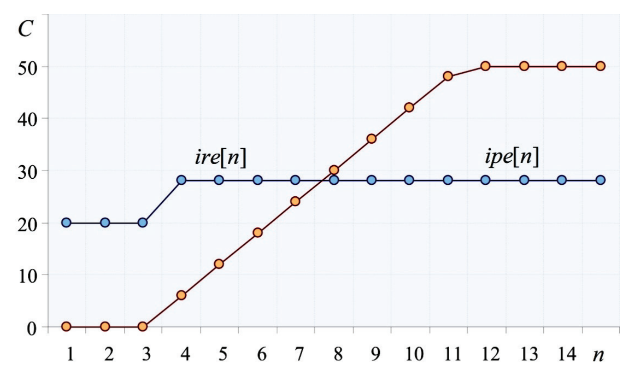


Fig. 10. Timing diagrams of functions *ire*[*n*] and *ipe*[*n*]

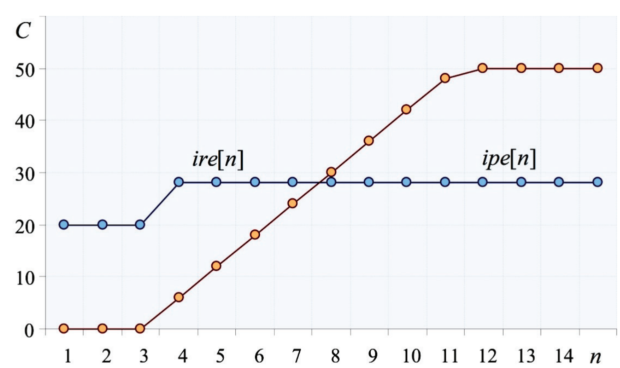


Fig. 11. Timing diagrams of functions *vre*[*n*], *vpe*[*n*] and *dif*[*n*]

ISSN 2226-3780

Let's introduce one more notation:

$$r[n]=\int_0^t\left[\int_0^t\left(\int_0^t re(t)\mathrm{d}t\right)\mathrm{d}t-\int_0^t\left(\int_0^t pe(t)\mathrm{d}t\right)\mathrm{d}t\right]\mathrm{d}t,$$

which is equivalent to defining the function $r[n]$ using the functions $vre[n]$ and $vpe[n]$. Because the:

$$R=\int_0^{t_a}\left[\int_0^t\left(\int_0^t re(t)\mathrm{d}t\right)\mathrm{d}t-\int_0^t\left(\int_0^t pe(t)\mathrm{d}t\right)\mathrm{d}t\right]\mathrm{d}t,$$

let's determine the value of the resource intensity of the logistic operation at the time of integration of the function (Fig. 12):

$$r[n]=r[n]+dif[n]+r[n-1].$$

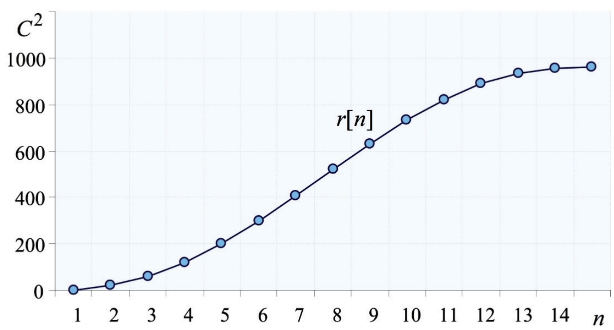


Fig. 12. Timing function $r[n]$

According to [20], the *ELF* is determined by the ratio of the potential effect of the operation:

$$AE=\frac{\left(\sum pe[n]-\sum re[n]\right)}{2}=\frac{(PE-RE)}{2},$$

to the value of its resource intensity (R). That is, $ELF=AE/R$.

However, the valuation of the prognostic flow of unsold production $fe[n]$ reflects unmet demand, which leads to outflow of loyal customers. If to introduce the penalty function (PE) into the definition of the potential effect, where $FE=k\sum fe[n]$, and k – the penalty coefficient, the expression for determining the potential effect can be represented in the form:

$$AE=\frac{(PE-RE-FE)}{2}.$$

If assume that k=2, it is possible to determine the effectiveness of a deficit operation:

$$ELF=\frac{(50-28-2\cdot 10)}{2\cdot 960}=0.001042.$$

6.3. Determination of the insurance stock level of the logistics operation. To assess the logistics operations using the proposed method, a software product was developed, which was implemented using the capabilities of Excel and Visual Basic for Application [23].

The interface part of the program requires the input of the following initial data: total time of the logistic operation, volume of the input batch of products, unit cost of the input batch of products, delivery cost, delivery time, volume of the conventionally transferred input batch of products, average level of demand, cost of the output batch unit of products, penalty for the deficit (Fig. 13).

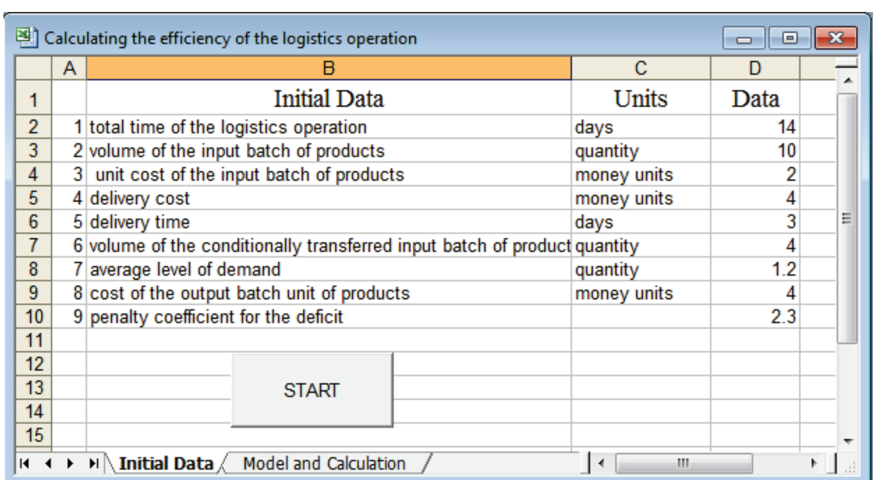
The starting field of the calculation part of the program becomes available for study the entire calculated part of the method and the final results of the calculation (Fig. 14).

Fig. 15 shows the change in the efficiency of logistics operations, in which one parameter – the level of demand changes. As a result of the change in demand, the type of operation is transferred from the category of surplus, to the category of deficit.

To evaluate the efficiency of the logistics process, it is necessary to find the ratio:

$$ELF=\frac{\sum AE}{\sum R},$$

where $\sum AE$ – the sum of the potential effects of the sequence of logistics operations; $\sum R$ – the total resource intensity of the sequence of logistics operations.



	A	B	C	D
1		Initial Data	Units	Data
2	1	total time of the logistics operation	days	14
3	2	volume of the input batch of products	quantity	10
4	3	unit cost of the input batch of products	money units	2
5	4	delivery cost	money units	4
6	5	delivery time	days	3
7	6	volume of the conditionally transferred input batch of product	quantity	4
8	7	average level of demand	quantity	1.2
9	8	cost of the output batch unit of products	money units	4
10	9	penalty coefficient for the deficit		2.3

Fig. 13. The interface part of the program for calculating the level of the insurance stock of the logistics operation

Calculating the efficiency of the logistics operation

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1								RE	PE	FE				R	AE	ELF
2								32	54.40	0				1872	11.2	0.00598
3	n	rq_v	rq_c	dq	pq_s	fq	pq_c	re	pe	fe	ire	ipe	vre	vpe	dif	r
4	0															
5	1	10						24			24	0	0	0	0	0
6	2										24	0	24	0	24	24
7	3										24	0	48	0	48	72
8	4		4	1.2	1.2			8	4.80		32	4.8	72	0	72	144
9	5			1.2	1.2				4.80		32	9.6	104	4.8	99.2	243
10	6			1.2	1.2				4.80		32	14.4	136	14.4	121.6	365
11	7			1.2	1.2				4.80		32	19.2	168	28.8	139.2	504
12	8			1.2	1.2				4.80		32	24	200	48	152.0	656
13	9			1.2	1.2				4.80		32	28.8	232	72	160.0	816
14	10			1.2	1.2				4.80		32	33.6	264	100.8	163.2	979
15	11			1.2	1.2				4.80		32	38.4	296	134.4	161.6	1141
16	12			1.2	1.2				4.80		32	43.2	328	172.8	155.2	1296
17	13			1.2	1.2				4.80		32	48	360	216	144.0	1440
18	14			1.2	1.2		0.8		6.40		32	54.4	392	264	128.0	1568
19	15										32	54.4	424	318.4	105.6	1674
20	16										32	54.4	456	372.8	83.2	1757
21	17										32	54.4	488	427.2	60.8	1818
22	18										32	54.4	520	481.6	38.4	1856
23	19										32	54.4	552	536	16.0	1872
24	20										32	54.4	584	590.4	-6.4	

Initial Data | Model and Calculation

Fig. 14. Results of calculating the efficiency of the logistics operation model

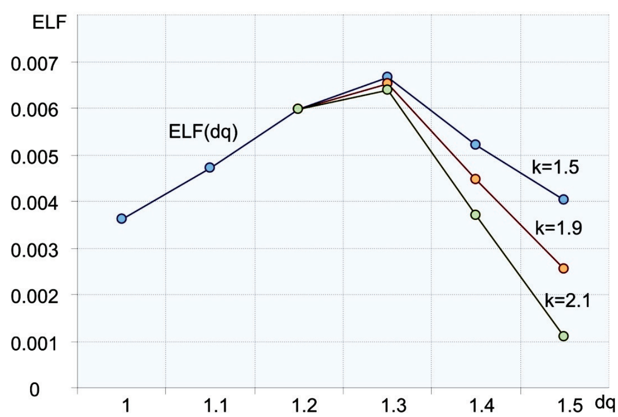


Fig. 15. Change in the effectiveness of operations, depending on the level of demand and the penalty coefficient (k)

The developed method for effectiveness evaluation of logistics operations and processes can be used to evaluate alternative technological forecasting. This will allow to choose an economically justified forecasting method and a reasonable amount of insurance stock.

Fig. 16 depicts a diagram of the change in the current level of company stocks in the replenishment modeling process using standard forecasting technology.

In the process of increasing the level of reserves, the number of deficit areas decreases (Fig. 17).

At the same time, an increase in the level of stocks initially leads to an increase in the efficiency of the logistics operation, and then to a decrease (Fig. 18).

At the same time, the efficiency indicator of the logistics process first increases, with the growth of the level of the insurance stock, and then, begins to decline.

The level of insurance stock, which corresponds to the maximum efficiency of the logistics process, is a systematically justified level of stock. In this case, its level is 40 units.

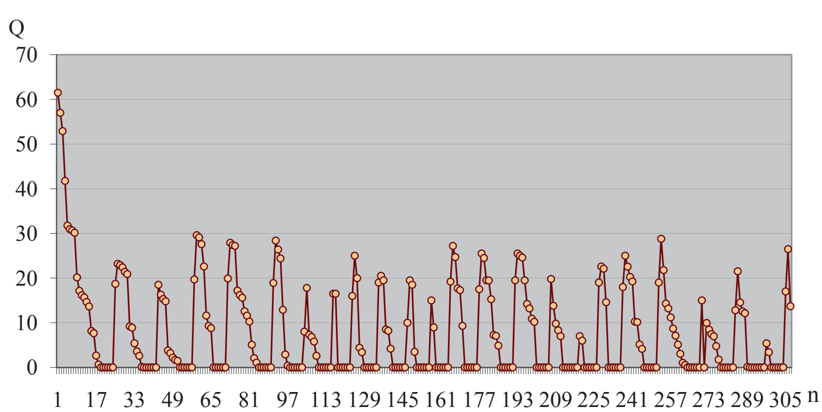


Fig. 16. Formation of logistics process with zero level of insurance stock

ISSN 2226-3780

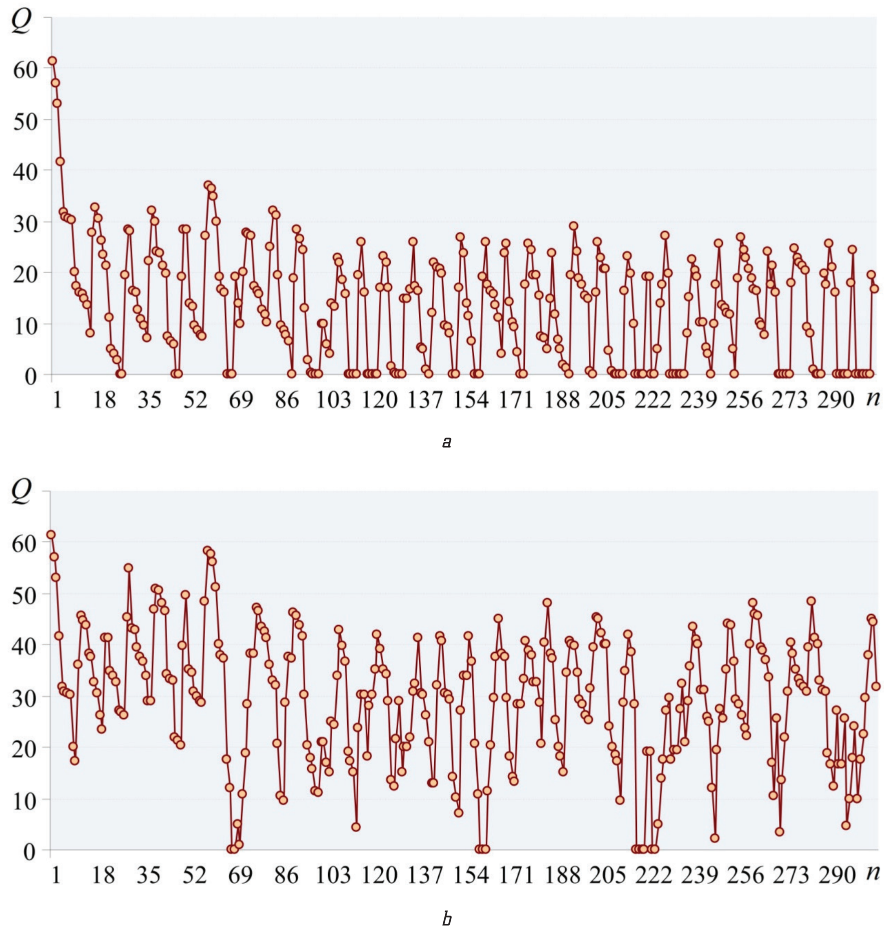


Fig. 17. Formation of logistics process with different levels of insurance stock of 40 units

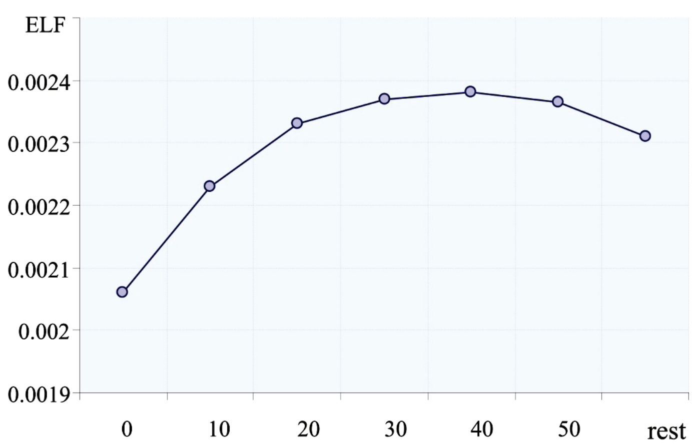


Fig. 18. Changing the efficiency of the logistics operation from the stock level

As the research results have shown, the calculation of a systemically sound level of logistics operations is the most difficult management issue. This complexity is due to the fact that the insurance stock can't be determined without taking into account the level of demand, the mark-up of production, the possibility of prompt replenishment of stocks. For example, with equal volumes of consumption, the insurance stock should be the higher, the more buyers need it. Also, the insurance stock should be the higher, the higher the profit that the product brings.

Thus, statistical methods of data processing can't fundamentally be used to determine the amount of insurance stock, since traditional methods based, as a rule, on the determination of the standard deviation, the above-described factors are not taken into account in principle.

The proposed method is based on the effectiveness evaluation of operations, and therefore is free from the drawbacks of statistical methods.

Thus, products with a higher mark-up automatically receive a higher level of stocks, and the volume of buyers can be taken into account by changing the coefficient of the penalty function.

7. SWOT analysis of research results

Strengths. The strength of the conducted researches is the possibility of obtaining a systematically reasonable answer regarding the definition of the optimal level of the insurance stock in the buffering systems. This takes into account all the significant factors that affect the decision. Since the input and output quantitative parameters of the products of the operation are reduced to comparable values, the efficiency index is used as an optimization criterion.

Weaknesses. The weak side is that the issue of determining the coefficient of the penalty function requires the consideration and processing of data that are difficult to quantify accurately. For example, information is required about the level of demand for a logistics operation product. At the same time, the nature of the relationship between the level of demand and the value of the penalty function coefficient is nonlinear and the form of this nonlinearity has not been identified to date.

Opportunities. Opportunities for further research are the definition of the functional dependence of the fringe penalty for the deficit with external factors such as product profitability and the level of demand.

Threats. Threats to the results of the conducted research are the processes associated with the impact on consumer demand, which, in turn, affects the accuracy of determining the insurance stock level.

8. Conclusions

1. A model of a logistics operation is defined, which, depending on the level of demand, can be excessive, consistent and deficit.

It is established that each subsequent operation of the executive system interrupts the course of the current operation. At the same time, if at the moment of the interruption of the current operation in the buffering system there is a non-zero level of stocks, a system product defined by the term «conditionally transferred batch of products» is formed. In relation to the current operation, this batch of products is the output batch, with respect to the subsequent operation – the conditionally transferred input batch.

2. It is established that in determining the efficiency of a logistics operation, the efficiency formula must take into account the possibility of a deficit in the finished product. At the same time, the penalty function should reduce the value of the added value of the operation, since a shortage of finished products leads to a decrease in the level of demand due to the outflow of regular customers.

When determining the efficiency of a logistic operation, the output conditionally transferred batch of products has a valuation of the equivalent input product, so it does not create added value.

3. The ability to determine the effectiveness of a logistics operation taking into account the consistency of demand provides the opportunity to determine the value of a systematically justified insurance stock.

References

1. Lutsenko, I. Development of executive system architecture of the converting class [Text] / I. Lutsenko, E. Fomovskaya, O. Serduik // Eastern-European Journal of Enterprise Technologies. – 2016. – Vol. 4, No. 2 (82). – P. 50–58. doi:10.15587/1729-4061.2016.74873
2. Lutsenko, I. Synthesis of cybernetic structure of optimal spooler [Text] / I. Lutsenko, E. Fomovskaya // Metallurgical and Mining Industry. – 2015. – No. 9. – P. 297–301.
3. Kovrik, E. V. Logistics inventory management in conditions of systemic risk and financial constraints of the enterprise [Text] / E. V. Kovrik // MIR (Modernization. Innovation. Research). – 2014. – No. 1. – P. 97–99.
4. Dziuba, S. A. Izderzhki gibkogo proizvodstva i optimal'nyi razmer zakaza [Text] / S. A. Dziuba // Ekonomicheskii analiz: teoriia i praktika. – 2011. – No. 1 (218). – P. 52–57.
5. Vasilieva, N. F. About the possibility of application of the formula for the optimal size of order to manage inventory in ferrous metallurgy [Text] / N. F. Vasilieva // Vestnik of Nosov Magnitogorsk State Technical University. – 2013. – No. 3. – P. 106–109.
6. Picavet, E. Opportunities and pitfalls for ethical analysis in operations research and the management sciences [Text] / E. Picavet // Omega. – 2009. – Vol. 37, No. 6. – P. 1121–1131. doi:10.1016/j.omega.2008.12.002
7. Merigo, J. M. A bibliometric analysis of operations research and management science [Text] / J. M. Merigo, J.-B. Yang // Omega. – 2017. – Vol. 73. – P. 37–48. doi:10.1016/j.omega.2016.12.004
8. Hassin, R. Operations research applications of dichotomous search [Electronic resource] / R. Hassin, A. Sarid // European Journal of Operational Research. – 2017. – Available at: \www/URL: http://www.sciencedirect.com/science/article/pii/S0377221717306586. doi:10.1016/j.ejor.2017.07.031
9. Giannopoulos, G. A. Strategic management and promotion issues in international research cooperation [Text] / G. A. Giannopoulos // Case Studies on Transport Policy. – 2017. – Vol. 5, No. 2. – P. 438–451. doi:10.1016/j.cstp.2016.08.001
10. Lutsenko, I. Development of a verification method of estimated indicators for their use as an optimization criterion [Text] / I. Lutsenko, E. Fomovskaya, I. Oksanych, S. Koval, O. Serdiuk // Eastern-European Journal of Enterprise Technologies. – 2017. – Vol. 2, No. 4 (86). – P. 17–23. doi:10.15587/1729-4061.2017.95914
11. Asllani, A. A simulation-based apheresis platelet inventory management model [Text] / A. Asllani, E. Culler, L. Ettkin // Transfusion. – 2014. – Vol. 54, No. 10pt2. – P. 2730–2735. doi:10.1111/trf.12570
12. Lindstedt, M. Optimal control of pump rotational speed in filling and emptying a reservoir: minimum energy consumption with fixed time [Text] / M. Lindstedt, R. Karvinen // Energy Efficiency. – 2016. – Vol. 9, No. 6. – P. 1461–147. doi:10.1007/s12053-016-9434-y
13. Pfau, T. Real-Time Implementation of High-Speed Digital Coherent Transceivers [Text] / T. Pfau // Enabling Technologies for High Spectral-Efficiency Coherent Optical Communication Networks. – John Wiley & Sons, Inc, 2016. – P. 435–446. doi:10.1002/9781119078289.ch12
14. Berhanu, B. M. Feasibility of Water Efficiency and Reuse Technologies as Demand-Side Strategies for Urban Water Management [Text] / B. M. Berhanu, M. Blackhurst, M. J. Kirisits, P. Jamarillo, D. Carlson // Journal of Industrial Ecology. – 2016. – Vol. 21, No. 2. – P. 320–331. doi:10.1111/jiec.12430
15. Jia, H. W. Irrigation Water Use Efficiency Based on the Deficit Irrigation Theories [Text] / H. W. Jia, L. L. Zheng // Advanced Materials Research. – 2013. – Vol. 864–867. – P. 2179–2184. doi:10.4028/www.scientific.net/amr.864-867.2179
16. Yakubovskaia, T. L. Otsenka effektivnosti logisticheskih protsessov predpriiatiia [Text] / T. L. Yakubovskaia, V. V. Alimova // Materialy Mezhdunarodnoi nauchno-prakticheskoi konferentsii, posviashchennoi 60-letiiu avtotraktornogo fakul'teta «Logisticheskie otnosheniia v sfere transportnyh protsessov». – Minsk: BNTU, 2011. – P. 84–89.
17. Skochinskaia, V. A. Metody rascheta obiema strahovogo zapasa s uchetom znachimosti material'nyh resursov [Text] / V. A. Skochinskaia // Vestnik BNTU. – 2007. – No. 5. – P. 52–57.
18. Yashin, A. A. Logistika. Osnovy planirovaniia i otsenki effektivnosti logisticheskih sistem [Text] / A. A. Yashin, M. L. Riashko. – Ural, 2014. – 52 p.
19. Bigel, D. Upravlenie proizvodstvom [Text] / D. Bigel. – Moscow: Mir, 1973. – 303 p.
20. Lutsenko, I. Identification of target system operations. 4. The practice of determining the optimal control [Text] / I. Lutsenko, E. Fomovskaya // Eastern-European Journal of Enterprise Technologies. – 2015. – Vol. 6, No. 2 (78). – P. 30–36. doi:10.15587/1729-4061.2015.54432
21. Lutsenko, I. Development of the method for testing of efficiency criterion of models of simple target operations [Text] / I. Lutsenko, E. Vihrova, E. Fomovskaya, O. Serdiuk // Eastern-European Journal of Enterprise Technologies. – 2016. – Vol. 2, No. 4 (80). – P. 42–50. doi:10.15587/1729-4061.2016.66307
22. Lutsenko, I. Formal signs determination of efficiency assessment indicators for the operation with the distributed parameters [Text] / I. Lutsenko, E. Fomovskaya, I. Oksanych, E. Vikhrova, O. Serdiuk // Eastern-European Journal of Enterprise Technologies. – 2017. – Vol. 1, No. 4 (85). – P. 24–30. doi:10.15587/1729-4061.2017.91025

ISSN 2226-3780

23. Logistic_operation_efficiency.xls [Electronic resource]. – Available at: \www/URL: https://www.dropbox.com/s/5b7xv4z2xcv4uta/Logistic_operation_efficiency.xls?dl=0

РАЗРАБОТКА МЕТОДА ФОРМИРОВАНИЯ СИСТЕМНО ОБОСНОВАННОГО УРОВНЯ ЗАПАСОВ ЛОГИСТИЧЕСКИХ ОПЕРАЦИЙ

Производственная или торговая деятельность всегда связана с необходимостью исследования и формирования параметров логистических операций. Несмотря на продолжительную историю и большое количество проведенных исследований в настоящее время отсутствуют системно обоснованные методы определения оптимальних параметров логистических операций. Предлагаемый поход обеспечивает возможность создания модели логистической операции и определения системно обоснованного уровня страховых запасов.

Ключевые слова: логистическая операция, модель логистической операции, страховой запас логистической операции.

Lutsenko Igor, Doctor of Technical Sciences, Professor, Department of Information and Control Systems, Kremenchuk Mykhailo Ostrohradskyi National University, Ukraine, e-mail: delo-do@i.ua, ORCID: http://orcid.org/0000-0002-1959-4684

Fomovskaya Elena, PhD, Associate Professor, Head of the Department of Electronic Devices, Kremenchuk Mykhailo Ostrohradskyi National University, Ukraine, e-mail: 2fill.fo@gmail.com, ORCID: http://orcid.org/0000-0002-8065-5079

UDC 005.21:339.138 (045)
DOI: 10.15587/2312-8372.2017.113120

Dligach A.

DEVELOPMENT OF MARKETING STRATEGIES IN SYSTEM-REFLEXIVE MARKETING

Запропоновані інтегрована система системно-рефлексивного маркетингу, що базується на програмній формі управління, та трициклічна модель формування стратегії, як сукупність методів, форм та інструментів узгодження інтересів стейкхолдерів на трьох рівнях: опредмечення інтересу управителя по відношенню до об'єкта управління; узгодження інтересів внутрішніх стейкхолдерів; формування стратегії в процесі узгодження інтересів зовнішніх стейкхолдерів. Застосування системно-рефлексивного маркетингу підвищує ефективність та конкурентоспроможність підприємств в умовах глобалізованості ринкового середовища.

Ключові слова: *стратегічний маркетинг, стратегічне управління, системно-рефлексивне стратегічне маркетингове управління, системно-рефлексивний маркетинг.*

1. Introduction

The current stage of development of the world economy, in particular the approach of the phase transition, the essential changes in consumer needs and behavior, the development of the knowledge economy requires new approaches in making managerial decisions, and should take into account the prospects for the formation of new markets and market niches. The intensity of competition is increasing both on the global market and on its local sectors, which leads to the need to develop marketing competencies of enterprises. Low rates of economic growth and the urgent need for drastic changes in the economy of Ukraine, which, in particular, provides for the management and technological modernization of enterprises, the development of postindustrial sectors of the economy, the development of small and medium-sized businesses requires increasing the marketing competencies of managers and the introduction of proactive strategic approaches in entrepreneurship. Under such conditions, the formation of a strategic competitive position of enterprises becomes possible, in particular, by introducing a system-reflexive strategic marketing management to accelerate the diffusion of managerial and market innovations, aligning interests in partnerships, and applying proactive market management.

2. The object of research and its technological audit

The object of research is the strategic marketing activity of enterprises in the conditions of transformation of the market environment in Ukraine. The subject of research is the theoretical and methodological foundations of system-reflexive strategic marketing management in the activities of Ukrainian enterprises and the formation of marketing strategies.

3. The aim and objectives of research

The aim of research is development of a methodology and practical application of system-reflexive strategic marketing management (SRSMM). According to the aim of the research, the following tasks are set:

1. Studying of the genesis and conceptual foundations of the formation of strategic marketing management system at enterprises.
2. Formation of the SRSMM system, which integrates strategic marketing solutions into a single system of marketing strategies focused on strengthening competitive positions in the global market environment.
3. Definition of the mechanism for formation of marketing strategies in SRSMM at the enterprise.