Creation of model of optimizing the choice of effective distribution channels of finished products under risk and uncertainty, taking into account the environment of the enterprise

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Abstract: In this article the author consider the problem of a choice of a way of the organization of work of distribution system of finished goods of manufacturing enterprise for a situation when along with risk factors is consider uncertainty of environment of the enterprise.
[Andrianova N.V. **Creation of model of optimizing the choice of effective distribution channels of finished products under risk and uncertainty, taking into account the environment of the enterprise.** *Life Sci J* 2014;11(8):784-789]. (ISSN:1097-8135). http://www.lifesciencesite.com. 117

Key words: the distribution channel, uncertainty of environment of the enterprise, risk factors, optimizing model of a choice of distribution system.

1. Introduction

Economic activity is any business entity is realized in terms of ambiguity (uncertainty) flow of the real socio-economic processes, variety of possible states and situations of implementation of the decision. Subsystems (the separate enterprises) systems of distribution of finished goods are dependent from each other owing to interactions, and the decision of one participant can affect several participants of a network at the same time, that is functioning of system of distribution of finished goods can't be completely defined and is respectively fully described by the linear analytical equations [1]. The main sources of uncertainty include lack of knowledge on the economic sphere, the surrounding world; the randomness of events (equipment failure and sudden change in product demand, a sudden disruption of supply of raw materials); resistance, which can manifest itself in case of breach of contractual rights under uncertainty in product demand, its sales difficulties. At the same time with the uncertainty of the environment, which is the lack of information about likely future developments, the manager faces risks that are probabilistic or statistical evaluation. Risk factors with regard to the situation here can be delayed deliveries on the way of the material flow in the distribution network, and changes to the material flow caused by specific members of the supply chain, as well as third-party intervention.

The choice of effective distribution channel in tackling this task refers to the definition of such a combination of legal and natural persons involved in the process of bringing the goods from the manufacturer to the consumer who most closely meet the requirements of the manufacturer.

2. Model of optimization selecting of effective distribution channels of finished products

Building a model of optimization selecting of effective distribution channels of finished products under conditions of risk and uncertainty will be executed in phases.

1 stage. Define factors or parameters that can affect the choice of distribution channels, and which must be taken into account when building the optimization model selection:

C is the annual consumption of products, units;

Co_{an} is the total annual cost of sales by channel of distribution, rub.

When solving the task manager is faced with problems of choice among several alternatives with many of the criteria. In decision theory such criteria referred to by private. Imagine the selection criteria on which annual cost of product distribution in the form of the following:

Co_c is the constant costs for the sale of products through the distribution channel, rub;

Co_v is the cost variables on sales by distribution channel, rub.

We carry to variable expenses: costs of transportation, of purchase of material resources, of stockpile management (storage, insurance, losses from damage of values, etc.), on management of orders (receiving and processing of orders, cargo handling, packing, information support, detection and marriage correction, placement of orders, the organization of calculations with consumers, etc.); on warehousing (the maintenance of own warehouses, rent of external warehouses, repair and service of the warehouse equipment, loss from damage and shortage of values, protection of freights, cargo handling, etc.). Constant can be considered administrative expenses,

depreciation and disposal of administrative buildings and equipment independent of sales volumes.

The rate of total annual costs, in general, should include or take into consideration advanced and some other costs within the business. But in our case, we do not take into account costs that are not directly related to our task, because they do not affect the choice of the optimal solution. On the formalization of the model, these costs are not taken into account.

The structure of the set of private criteria is driven by the need to manage the risks that may affect the resulting performance criteria. Such risk factors may be:

- delay of the delivery of goods from the manufacturer to the wholesaler or retailer;
- marriage or re-grading the fault of the manufacturer.

The risk factors directly affect variable costs on the sale of products.

P is the price of a unit of product, rub;

S is the average annual volume of sales (turnover) by channel of distribution, rub;

O is the number of orders by year;

Pr is the general annual profit to the taxation, rub.

The problem of maximizing the general annual profit of Pr can be presented in a look:

$$\Pr = S - Co_v - Co_c \to \max \quad (1)$$
$$S > 0$$

The average annual sales volume of production on each channel of distribution is representable as follows:

$$S = C \times P \quad (2)$$

Thus annual consumption of production (C) can change within a year. Not to do model excessively bulky, let us assume, that change of annual consumption it is possible to apply only to two scenarios (figure 1).

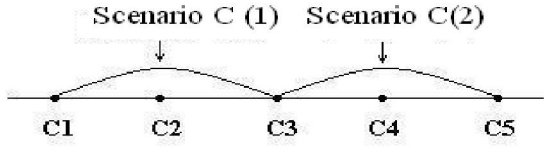

Figure 1. Borders of possible changes of size of annual consumption

Demand for production in a year can be: the low – the scenario C (1), that is C ∈ [C1, C3); the high – the scenario C (2), that is C ∈ [C3, C5].

At formalization of optimizing model possibility of delivery of production to different intermediaries, and on different delivery terms and with the different price of a unit of production (table 1) is considered. We will review an example of distribution of production the milk-processing enterprise (figure 2). We will conditionally accept (for bulkiness reduction) that the producer has two ways of entry into the market (own network of retail shops and independent network retail).

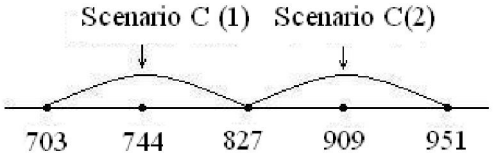

Figure 2. Possible scenarios of change of demand for a product, one thousand conditional liters

On the basis of statistical data concerning scenarios of influence of such factors it is defined that production delay in delivery, marriage and regrading because of the producer can lead to the following consequences:

- to shift of schedules of delivery to retail points of sales that will lead to growth of expenses for transportation, on production storage, on management of orders;
- to increase in volumes of cargo handling due to addition of operations of processing and repacking of rejected production, to the room of production in a marriage zone, and also to increase in administrative and operating expenses at production return to the supplier
- to deficiency of goods on the shelf that in turn will lead to increase in volume of an indicator of the missed profit of the enterprise as a whole.

We will designate in possible scenarios of events lack of risk factor or its insignificant influence on the size of expenses as "–", considerable influence – "+". Thus risk factor "the delay in a way" on the basis of statistical data of work of the enterprise increases variable costs of 10%, "marriage and regrading because of the producer" – by 15%.

The delay in a way occurs:

- with probability 0,13 – in case of the organization of sale of the producer for the first distribution channel;
- with probability 0,2 – at production sale on the second distribution channel.

The delay in delivery is absent or causes insignificant damage of profit with probability 0,87 at alternative "Channel 1" and with probability 0,8 at alternative "Channel 2".

Marriage and production regrading because of the producer happens:

- with probability 0,1 – in case of the organization of sale of the producer for the first distribution channel;

- with probability 0,15 – at production sale on the second distribution channel.

Marriage and production regrading because of the producer is absent or causes insignificant damage of profit with probability 0,9 at alternative "Channel 1" and with probability 0,85 at alternative "Channel 2".

Table 1. Parameters of model of implementation of scenarios for each intermediary

Model parameters	Designations			
	Channel 1		Channel 2	
Price of sale of production, rub.	P_1=25		P_2=25,5	
The constant costs, thousand rubles.	Co_{c1}		$Co_{c\,2}$	
	431	431	246	246
The variable costs, thousand rubles.	Delay in a way (D)			
	– (0,87)	+ (0,13)	– (0,8)	+ (0,2)
	$Co_{v\,1}$		$Co_{v\,2}$	
		+10%		+10%
The variable costs, thousand rubles.	Marriage and regrading because of the producer (M)			
	– (0,9)	+ (0,1)	–(0,85)	+(0,15)
	Co_{v1}		Co_{v2}	
	17458	+15%	17458	+15%

Within model of a choice of the distribution channel considered further definition of the optimum or best decision includes a choice of the intermediary which will make for the producer the greatest profit with the smallest losses at the expense of the optimum amount of commodity turnover on the distribution channel. Finding of such decision, is natural, complicated because it is in advance not known, in what concrete combination values for the parameters of model stated above in the conditions of uncertainty will be realized.

2 stage. We will carry out step by step procedures of formalization of model of a choice of the channel of distribution in the conditions of uncertainty and taking into account risk.

Step 1. At many criteria taking into account risk factors it is necessary to apply convolution and blocking procedures to a choice of the best decision.

Procedure of convolution consists in transformation of a set of parameters taking into account distribution of probabilities of emergence of different random factors in the set of parameters convenient for adoption of the administrative decision. At the neutral relation to risk of the manager approach of EVC-criterion (Expected Value Criteria) is used, and the result of convolution on this criterion has only one parameter: average expected values for considered private criteria [2]. Further we will consider optimization procedures on the basis of EVC-criterion.

Criterion «The variable costs» in alternative "Channel 1" in the absence of marriage and regrading because of the producer (probability of such event 0,9) will make 17458 thousand rubles, in the presence of marriage (probability 0,1) – 20077 thousand rubles (taking into account growth of expenses by 15%). As a result of convolution procedure for an indicator of this criterion we receive: 17458*0,9+20077*0,1=17720 thousand rubles.

At production delay in a way variable costs increase by 10%: 17720*1,1=19492 thousand rubles. Following the results of convolution for this indicator we have: 17720*0,87+19492*0,13=17950 thousand rubles.

We make the same for alternative "Channel 2". We receive variable costs of 18208 thousand rubles.

Step 2. We formalize full group of casual events (Q) for considered model of a choice of the channel of distribution in the conditions of the uncertainty, influencing end economic result:

Q_1 is the event presented by a situation – C ∈ [C1, C3), D (–), M (–), when annual consumption of production low;

Q_2 is the event presented by a situation – C ∈ [C3, C5], D (–), M (–), when annual consumption of production high.

Such events can be more depending on number of the considered parameters which within a year can change, and these changes can't be predetermined precisely.

Step 3. We formalize a matrix of profits. Such matrix represents end economic result (revenue or profit) in relation to each analyzed decision and each casual event. At formalization of a matrix of profits for each its cell it is required to determine the corresponding size of expected annual profit Pr_{ij} as element of such matrix for a case when the solution of X_j (from a set of analyzed alternative decisions) will be made, and the

situation will consist Q_i (of a set of the situations influencing economic result).

Table 2. Matrix of profits

	X_1	X_2	…	X_j
Q_1	Pr_{11}	Pr_{12}	…	Pr_{1j}
…	…	…	…	…
Q_i	Pr_{i1}	Pr_{i2}	…	Pr_{ij}

For definition of expected profit Pr_{ij} we will use equality:

$$\Pr = S - Co_c - Co_v \quad (3)$$

In relation to this equality we will note the following:

• parameter S in a formula (3) for expected annual profit of Pr directly depends on demand for production (C) by each channel and from the realization price per unit of output (P) and it will be determined in relation to each analyzed event of Q_i;

• parameter C is defined by scenarios of succession of events which are realized irrespective of decisions and desires of the manager;

• parameters Cco_c and Cco_v are defined for each analyzed.

If there comes Q_1 event (the event presented by a situation – C ∈ [C1, C3) when annual consumption low, at alternative of X_1 "Channel 1" for the corresponding size of expected annual profit of Pr_{11} on the basis of the formula (3) we receive equality:

$$\Pr_{11} = C2 \times P_1 - Cco_{c1} - Cco_{v1} \quad (4)$$

Similarly for the Pr_{12}– Pr_{22} elements of this line of a matrix of profits is had the following equality:

$$\Pr_{12} = C2 \times P_2 - Cco_{c2} - Cco_{v2} \quad (5)$$

$$\Pr_{21} = C4 \times P_1 - Cco_{c1} - Cco_{v1} \quad (6)$$

$$\Pr_{22} = C4 \times P_2 - Cco_{c2} - Cco_{v2} \quad (7)$$

We will give results in a matrix of profits (table 3).

Table 3. Matrix of profits

	X_1	X_2
Q_1	219	418
Q_2	4344	4626

Step 4. We realize a choice of the alternative decision on the basis of the concrete criterion reflecting the relation of the person, making the decision, to uncertainty of the end result. The choice of criterion is carried out by directly manager. The decision-making theory in the conditions of uncertainty offers rather wide list of such criteria to give the chance to the manager to consider various relations to risk of casual losses of profit. Them represent respectively special groups of such criteria: classical criteria; derivative criteria; compound criteria of decision-making in the conditions of uncertainty [3]. To classical traditionally carry: maximine criterion; optimistic criterion; neutral criterion; criterion of Sevidzh. To derivative criteria of optimization of decisions in the conditions of uncertainty, as a rule, refer criteria which modify or generalize classical criteria: Gurvits's criterion; criterion of works; Germeyer's criterion. In certain circumstances each of these methods has the merits and demerits which can help with decision development [4].

1. Choice on the basis of Gurvits's modified criterion in relation to a matrix of losses of Sevidzh ($HW_{mod(S)}$). At this criterion the expert «weighs» estimates which within this modification of criterion correspond to two «extreme» approaches to decision-making on a matrix of losses: to the approach corresponding to an extreme pessimistic or careful position which is used in criterion of Sevidzh; to the approach corresponding to a position of «extreme» optimism, but realized taking into account that the corresponding procedures belong to a matrix of losses, instead of a matrix of profits. The decision in relation to which such «weighed» assessment will be the most acceptable gets out: in this case – the smallest as the assessment belongs to profit losses.

Criterion function of criterion can be presented as follows:

$$Z_{HW_{\mathrm{mod}(S)}} = \min_i \{K_i\} \quad (8)$$

$$K_i = c \times \max_j \{l_{ij}\} + (1-c) \times \min_i \{l_{ij}\} \quad (9)$$

l_{ij} is the elements of a matrix of losses (Sevidzh);

c is the corresponding «weight» coefficient accepting values c∈[0; 1]. The coefficient choice «c» is realized by the manager. We will accept that c =0,4, that is the expert trusts an indicator of the extremely careful pessimistic position for 40%, and to an indicator of an extreme optimistic position – for 60%.

We will present a matrix of losses (Sevidzh) (table 4), where:

$$l_{ij} = \max_i \{a_{ij}\} - a_{ij} \quad (10)$$

l_{ij} is the corresponding losses if the solution of X_i is made, and the situation will develop according to Q_j event.

Table 4. Matrix of losses (Sevidzh)

Solutions	Losses at events	
	Q_1	Q_2
X_1	199	0
X_2	282	0

We will present a required indicator and necessary procedures for its stay in the following matrix (table 5).

Table 5. Matrix for finding of the modified criterion of Gurvits in relation to a matrix of losses of Sevidzh

Losses at events	Solutions	
	X_1	X_2
Q_1	199	282
Q_2	0	0
Pessimism position $\max_j\{l_{ij}\}$	199	282
Optimism position $\min_i\{l_{ij}\}$	0	0
Indicator of $HW_{mod\,(S)}$-criterion (Ki)	0,4*199+0,6*0=79,6	0,4*282+0,6*0=112,8

As we see, the best (for this criterion – the smallest) indicator $HW_{mod(S)}$-criterion in our example corresponds to the decision X_1 ("Channel 1") as to this decision there correspond the smallest losses of profit.

2 . Choice on the basis of modification of criterion of Gurvits with a binding to a utopian point ($HW_{mod(UT)}$). The purpose of such modification that the choice on the basis of this criterion will be approached to more preferable values of indicators of the income. For this purpose to each element of any separate column of a matrix of profits the constant (depending on a column) by Δ_j, such that the maximum element of the corresponding column after such procedure was equal to the greatest of coordinates of a utopian point in an initial matrix of profits is added:

$$\Delta j = \max_i\{\max_j(a_{ij})\} - \max_i(a_{ij}) \qquad (11)$$

Then the corresponding modified matrix of profits will have an appearance:

$$A = (a_{ij} + \Delta_j) = (\hat{a}_{ij}) \qquad (12)$$

Criterion function of $HW_{mod(UT)}$-criterion can be presented as:

$$Z_{HW_{mod(YT)}} = \max_i\{K_i\} \quad (13)$$

$$K_i = c \times \min_j\{\hat{a}_{ij}\} + (1-c) \times \max_j\{\hat{a}_{ij}\} \qquad (14)$$

We will present necessary «additives»: $\Delta_1 = 4208; \Delta_2 = 0$.

Then the required indicator and necessary procedures for its stay is representable in the following matrix (table 6).

Table 6. Matrix for finding of the modified criterion of Gurvits with a binding to a utopian point

Profits at events in new system of coordinates	Solutions	
	X_1	X_2
Q_1	4427	4344
Q_2	4626	4626
Pessimistic criterion	4427	4344
Optimistical criterion	4626	4626
Indicator of $HW_{mod\,(UT)}$-criterion at c=0,4 (Ki)	0,4*4427+0,6*4626= 4546,4	0,4*4344+0,6*4626= 4513,2

The biggest indicator of $HW_{mod(YT)}$-criterion in relation to the last matrix (it and the best) in our example corresponds to the decision X_1.

Therefore, by two criteria, used for finding of the optimum decision in the conditions of the uncertainty, the best is the decision X_1, that is sale of production of the enterprise for distribution system "Channel 1".

3. Conclusions

The choice of criterion has to be carried out taking into account concrete specifics of a solved task and according to goals, and also relying on last experience and own intuition of the manager. In particular, use of criteria in relation to a matrix of losses of Sevidzh allows to avoid any ways big risk at a strategy choice, so to avoid big loss. If the expert is aimed at his choice at more preferable values of indicators of the income, it is necessary to choose

criteria with a binding on a utopian point. For decision-making during design and reorganization of a network of distribution of the trading company it is necessary to consider a set of factors which will influence results and indicators of efficiency of functioning of system of distribution as a whole [5].

In this article the problem of a choice of a way of the organization of work of distribution system of finished goods of manufacturing enterprise for a situation when along with risk factors is consider uncertainty of environment of the enterprise. For descriptive reasons private criteria of a choice, and also risk factors are given in the minimum quantity. In practice the manager can increase their number depending on specifics of the enterprise and an objective.

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7/25/2014

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