



MODELS IN SUPPLY CHAIN MANAGEMENT IN ANIMAL HUSBANDRY

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ABSTRACT

Supply chain management is a critical aspect of conducting any business. In this article, we provide an overview of some of the methods for supply management and their use in animal husbandry. In this paper, we introduce a version of Wilson's model. The illustration of the proposed model, showing economic effects to the farm, reducing its expenses (by 2.5%) compared to farms that do not utilize this model.

Key words: economic order quantity, Wilson's model, inventory management, farm

JEL Classification: C13, L23, M11

INTRODUCTION

Managing supply deliveries is a crucial element of conducting an organization's business, particularly an animal farm. This process requires synchronization between deliveries, stored supplies and consumption, taking into account the effects of random factors. One of the efficient methods of gaining a competitive advantage is to reduce the expenses related to supply chain management.

The goal of the present study's authors is to perform an overview of several methods for supply management, including the renowned Wilson's method based on the example of an animal farm.

One of the set tasks is to apply the supply chain optimization model and evaluate its economic efficiency.

METHODS

We would first review the separation of expenses

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into different types when optimizing the volume of supplies (Stoykov, 2005).

- Expenses for preparing the order and delivery – contracting, quotation, implementation, etc.
- Transport expenses – a result of using either the company's own or specialized hired transport
- Expenses for storage maintenance, e.g. insurance, rent, security, etc.

Other authors have a similar view (Dimitrov P. et al., 2010), which emphasizes that supply chain management expenses have to be divided into three groups:

- expenses for maintaining supplies, including capital expenses,
- expenses for providing storage areas – the company's own or hired, as well as investments
- expenses for servicing the supplies – insurances and fees.

We must point out that several authors try to utilize the accounting of one more group of expenses, the so-called alternative expenses. These, according to (Duibskaya et al., 2014, p. 619), are invested financial resources used for purchasing the actual supplies. The claim is that this is just one way of using these funds. There would, of course, be other opportunities for the

farm, such as other business fields, which could bring income.

The models for supply management have been reviewed in detail by (Hristov, 2018).

We shall list their categories:

- Determined and stochastic models depending on the type of demand. Determined models imply the availability of information on the volume of demand, whereas the stochastic ones are based on a predicted value. Stochastic models, also known as “probability-based”, are described through a probability distribution. They can also be separated into the two categories above: stationary – in which the probability distribution of demand is constant, and non-stationary – the inverse variant.

- Static and dynamic models. If all model parameters do not change over time, the model is a static one. Otherwise, it is a dynamic one.

- Models allowing or not allowing deficit. Most of the supply management models are such that they do not allow a supply deficit.

- Models with limited or unlimited storage capacity, etc. They are reviewed in great detail by (Pavlov, A., 2015)

The lack of supplies could lead to some negative consequences, such as:

- Production disruption - When a business involves producing goods in addition to selling them, the shortfall means that the company will have to pay for things like unemployed workers and factory expenses, even when nothing is produced.

Customer Loyalty and Reputation - Aside from losing business from clients who go elsewhere to make purchases, the company is damaged by customer loyalty and reputation when their customers are unhappy (Khalil, M et al.2021)

Wilson’s model is from the first group of the so-called determined models. It is applied in two variants: not allowing deficit and the inverse. In this study, we shall only demonstrate the application of the first type, which does not allow supply deficit.

In its classic variant, Wilson’s model accounts for two primary groups of expenses:

- The organization’s delivery expenses

- Supply storage expenses

The theoretical model (economic order quantity EOQ model) is widely used in logistics. The model proposed by (Wilson,1934) allows determining the optimal order quantity – q , the optimal time between orders – T at which the total costs (TC) of purchasing and storing goods are minimal.

$$TC = C_s D/q + 1/2 C_1 T q - \min$$

Where C_s is the cost of delivery, D is demand for time horizon T , C_1 is the cost of storing a unit per day, Some assumptions in EOQ Model are given by (Kumar 2016): The formula is based on the following assumptions. Without these assumptions, the EOQ model cannot work to its optimal potential.

1. The demand rate for the year is known and evenly spread throughout the year.
2. There is no time gap between placing an order and receiving its supply.

RESULTS

Due to the specific nature of the needed facilities, personnel and equipment, storages are often one of the most expensive elements in the supply chain. Therefore their successful management is critical about the price of the offered product (Rushton, A., P. Croucher, and P. Baker, 2014). In our case, it is entered as an incoming resource in determining the cost of the animals. For the agrarian sector, given its dependence on the external environment (nature-climatic factor, elements of the nature-geographic complex, etc.), maintaining a high level of adaptability is particularly necessary, especially since the low level of adaptability, constitutes a danger to its completeness as such. (Velkovski, 2019)

As more agricultural organizations are outsourcing their transportation activities to specialized companies, it becomes increasingly critical to understand and evaluate logistics costs associated with transportation (Gao, T., Erokhin, V., & Arskiy, A. 2019).

Due to the high variation in the costs of the used fodders and the purpose of being less dependent on delivery speed, all animal farms have animal feed storage. In the form of feeds, the actual supplies provide an even satisfaction of the farm animals’ feed needs. It is well known that there

are some specifics in animal husbandry related to seasons, age, individual peculiarities, etc. Let us present a classic model for the optimal amount of an order of fodders for feeding the

farm animals. The variables of the classic model were taken from (Genchev, E., 2019).

Table 1. Variables used in the model

variable	measurement
D	Average feed demand, usually for a period of 1 year (in our case for 3 months);
P	Price per ton in BGN
C ₀	Costs per order (BGN / order)
C _h	Storage costs (BGN / per 1 unit / per one period) □
Q	Ordered quantity
q	optimal order size is calculated by Wilson's formula (Grubbström, 1995) $q = \sqrt{C_0 D / C_h}$
TC	Total costs (BGN) = (Acquisition costs) + (Order costs) + (Storage costs) = $DP + C_0 D / q + C_h q / 2$
T	Period between two orders

We will not examine the details of feeding cows in-depth, but we will point out fodders can be divided into three types: fresh forage, concentrated, and rough fodder. Every animal expectedly has individual requirements in this regard.

It would, of course, be necessary to create the so-called forage balance at the cow farm for the amount of forage needed per year. It is necessary that the herd would be divided into categories of animals. Their feed needs are evaluated depending on the age of the cows, heifers, and calves at 6-12 months old.

The demand for specific forage can be designated as D, measured in tons. Its price with (P), the delivery cost with C₀, would naturally depend on the order volume, but we will set it according to the costs of cargo services as an average of BGN 250. The cost of storing a unit of product (ton) is C_h or BGN 180 per period.

Let us apply the following initial data towards the implementation of our model. Assuming that the feeding of 100 cows requires the following amounts of feed for the next three months:

- Corn silage – 1200 kg daily, multiplied by 90 days = 108 tons. Cost per ton – BGN 350.
 - Concentrated forage – 700 kg daily, multiplied by 90 days = 63 tons. Cost per ton – BGN 500.
 - Sunflower meal – 250 kg daily, multiplied by 90 days = 22.5 tons. Cost per ton – BGN 600.
- Regarding the costs of transportation, we would assume specialized transport would be used. The average delivery cost (C₀) would be BGN 250. We should also note here that forage prices vary seasonally by 35-40%.

Based on the provided information, we have calculated that farm managers should order 27,000 kg of corn silage, 21,000 kg of concentrated feed, and 11,250 kg of sunflower meal to keep their inventory costs at their lowest. The period between two consecutive orders varies and is equal to 23 days for corn silage, 30 days for concentrated feed, and 45 days for sunflower meal. Assuming that, prior to the optimization model, the farm made five, four, and two deliveries of all three feed types per period. The total reduction of expenses would be BGN 500, or 2.5%.

Table 2. Wilson`s model in farm supply

	corn silage	concentrated feed	sunflower meal	total
D-kg	108000	63000	22500	193500
C_0 - BGN	250	250	250	
C_h -BGN / kg	0,18	0,18	0,20	
$q=\sqrt{C_0 D/ C_h}$	28868	22043	11859	
Number of orders for the period after - (q) application of the model = D / q	4 (3,74)	3 (2,85)	2 (1,90)	9
Recalculated quantities according to the number of orders	$108000/4=27000$	$63000/3=21000$	$22500/2=11250$	9
Total costs for ordering and storage = $D C_0/q + D C_h/2$	$1000+9720=10720$	$500+5670=6170$	$500+2250=2750$	19640
T- period between orders	$=90/4=22,5$ days	$=90/3=30$ days	$=90/2=45$ days	
Number of orders (q_1) for the period before the application of the model	5	4	2	11
Total costs for ordering and storage = $D C_0/q + D C_h/2$	$5 \times 250 + 9720 = 10970$	$4 \times 250 + 5670 = 6670$	$500 + 2250 = 2750$	20140
Model efficiency = Costs before applying the model - Costs after its application (in value and %)	250	250	-	500 ($500/20140=2,5\%$)

CONCLUSION

In conclusion, alongside its wide usage in various sectors, the supply chain optimization model is also applicable in the operation of an animal farm.

We should also clarify that it undergoes some modifications, such as price discounts for larger quantities and transport discounts for deliveries of larger volumes, something we will

demonstrate in further studies. Using the model brings economic effects to the farm, reducing its expenses (by 2.5%) compared to farms that do not utilize this model.

ACKNOWLEDGMENT

"The research leading to these results has received funding from the Ministry of education and science under the National science program INTELLIGENT ANIMAL HUSBANDRY, grant agreement № Д01-62/18.03.2021"

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PETROVA N., et al.

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