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## A VBA model for calculating partnership efficiency

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**A VBA model for calculating partnership efficiency**

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## **A VBA model for calculating partnership efficiency**

**JEL Classification:** *M29, C44, C61*

**Keywords:** *dynamic model; partnership efficiency; stock keeping theory; visual basic for applications*

**Abstract:** The article presents the development of a software application that focuses on calculating partnership efficiency. Partnership efficiency is part of the theory of stocks. This software is developed by using Microsoft Excel and the programming language Visual Basic for Applications. The main goal is to create a simple, user-friendly interface designed to calculate partnership efficiency among contractual partners. The contribution is based on the assumption that small and medium-sized enterprises do not use complicated IT systems, but to cater for their needs, they mainly use Microsoft Excel. The main contribution of the article is the software application that calculates, in a short term period, partnership efficiency among contractual partners. The created application is also designed for educational purposes (e.g. aimed to assist university students in absorbing the practical implementation of the Cooperation Model).

### **Introduction**

The Cooperation Model, which is part of operations management - namely the theory of stocks - can be a useful decision-making tool for companies regarding mutual cooperation between the company and the customer. Simultaneously, this topic is also taught at universities. Therefore, it is appropriate to create various teaching aids that enable students to better understand the topic. Whereas the Cooperation Model is quite simple, there is a question on how to calculate a situation where the chain (company – customer) enters the next subject, for instance, the next customer. The aim of the paper is to develop a simple application, using the Visual Basic for Applications (VBA) programming language, which allows to calculate the collaboration between two subjects or among three subjects. In the article

we present print screens of the application calculating the collaboration between two subjects.

### **Methodology of the research**

**In the article we present an example of using the VBA programming language in order to develop a simple software that practically presents the application of the cooperation model. VBA is the acronym for Visual Basic for Applications. It is an integration of Microsoft's programming language Visual Basic and Microsoft Office applications. By running Visual Basic IDE within the Microsoft Office applications, customized solutions and programs that enhance MS Office capabilities, can be developed. Among Visual Basic for applications, Microsoft Excel VBA is the most popular. Although MS Excel includes various formulas and functions, they are not enough for certain complex calculations and applications. In such cases, it would be relatively easier to write VBA code for such calculations. In the first part, we summarize the literature framework focused on the theoretical explanation of the cooperation model. In this section, we use a basic method, such as analysis, synthesis, comparison, deduction and generalization. In the next section of the article, we introduce the proposal of the interface that is based on the modelling methods and VBA coding. For the interface development we used the software Microsoft Excel 2013 and the specific function developer and the programming language Visual Basic for Applications. The object is the cooperation model and the subject is the interface development using VBA.**

### **Literature framework**

In many cases the management of optimal level of stocks is still determined by a subjective approach. But nowadays, there already exist several models of operation management. These so called models of stocks, are used to solve the optimization problems with the movement and management of stocks in the company (how much of stocks we need, when should we make an order of some material, what would be the amount of one delivery, etc.). In general “the operation management field encompasses the following decision areas: design of goods and services, managing quality, process and capacity design, location strategy, layout strategy, human resources and job design, supply chain management, inventory and material requirements planning, intermediate and short-term scheduling, and maintenance.” (Avella & Alfaro, 2014, p. 195) Operations

management provides solutions for many areas. That is why “the role of operations research and operations management is yet to be studied in depth.” (Gunasekaran et al., 2014, p. 806)

Models of stocks are classified according to several aspects. For example, depending on whether we consider the progress of consumption over time, a random effects on model or the movement of the stocks and so on. Models of stocks determined by the above aspects are then further divided into other “submodels” and strategies. An example could be the dynamic model with the stocks movement absolutely determined. In this model, the cooperation model has an interesting position. It is also called partnership efficiency. The essence of this model is to find out what situation is more effective for the cooperating parts (supplier vs. customer). It takes into account one’s own needs of delivery of some goods at a certain level of costs or makes a trade by mutual agreement for the amount of the delivery and divides the costs. Business partners could theoretically achieve better conditions within this mutual cooperation. Also, it is important to divide the mutual benefits between the participants of the trade. It is the win – win rule.

“Time and spatial separation of production and consumption leads to the need to solve the questions associated with stocks movement management. The inventory we will understand any incomplete use of resource intended to meet future demand, respectively future consumption.” (Sakál & Jerz, 2006, p. 306) Also, the size of this resource is determined in order to effectively meet the demand. By resource we mean finances, human resources, material assets etc. There is still the question: how much should we order? With surplus of stocks there is a risk of their economic or even physical impairment. On the other hand, the lack of supplies poses the risk of not meeting the requirements of customers.

„The stocks and supplying are important areas of management and production because the amount of capital held in stocks is on average about 16 % of total liabilities at manufacturing enterprises and about 20 % at commercial enterprises.“ (Sixta & Žižka, 2009, p. 61) „The costs of stocks keeping representing then from 20 % to 35 % of their nominal value.“ (Chase & Aquilano, 1995, p. 546)

In managing the stocks we use mathematical modelling. „With the questions of determining the amount of stocks, the method of their recharge and compiling the methods for this purpose deals the theory of stocks.“ (Sakál & Jerz, 2006, p. 306) The essence is to optimize the stocks, in other words, it is an effort to minimize the total costs of inventory management.

One of the possibilities on how to manage the stocks effectively is the cooperation model. This cooperation model is included in dynamic models of stocks, specifically it is the dynamic model with the movement of stocks

absolutely determined. The point is that these items should be regularly supplemented.

The cooperation means the agreement between business partners in order to reduce cost per one delivery. In the cooperation supplier and customer can achieve savings in defining a common amount for a delivery, despite the fact that cost optimum may not be achieved for each partner separately. Therefore, there is the win – win rule applied when the total net cost savings are fairly divided between business partners (50 to 50). For instance, in the form of discounts, credit note, etc.

Currently, many mathematical models are transformed into computer programs in order to automate various operations via macros. One of the tools is Visual Basic in Microsoft Excel. “Computer-aided technologies like Visual Basic Software have played a significant role in various science and engineering areas.” (Pal et al., 2014, p. 1835) This technology allows to solve for example “performing efficient and robust parameter estimation on nonlinear models; providing quantitative diagnostics of model fitting (including summary statistics that can be used for model comparison); optimizing the experimental design in the aim of maximizing the statistical power of model-based data analysis; assessing the results reproducibility at the group level (e.g., between-groups and between-conditions model comparisons).” (Daunizeau et al., 2014, p. 1) Also, the authors Dinesh et al. add that “Visual basic is a standalone tool for creating separate software components, such as executable programs, COM components and ActiveX controls which are useful to build a specialized solution of particular task.” (Dinesh et al., 2013, p. 198)

Microsoft Excel has a significant importance for small and medium enterprises. It is used more often in comparison with sophisticated IT systems such as SAP. The author Antlová indicates the barriers to the adoption of specific information systems in small and medium enterprises. “They are:

1. Technological barriers (problems of security, insufficient infrastructure).
2. Organisational barriers (management style, shortage of financial sources).
3. Barriers arising from the surrounding environment (insufficient knowledge of the market).
4. Individual barriers (insufficient knowledge, personal relations in organisation).” (Antlová, 2009, p. 151)

## Partnership efficiency in VBA model

Nowadays, there are specific software tools in order to facilitate the task of determining the optimal level of delivery, costs etc. But in many cases these tools include many functions and modules that are not used in the company. Despite this fact, the entrepreneur has to invest in the purchase of such software. Therefore, our goal is to simplify the determination of partnership efficiency, but without using some specific program. We have created a simple application by using Microsoft Excel and the VBA programming language.

The present work includes the development of a user-friendly interface, which is designed for small and medium enterprises and also designed for educational purposes (e.g. aimed to assist university students in absorbing the practical implementation of the *Cooperation Model*). The platform supports the automatic calculation of the following values

- Optimum Size of Delivery of a specific product for Customer and Supplier,
- Optimum Costs of Delivery for Customer and Supplier,
- New Costs for Supplier under the assumption that the customer's optimum size is accepted,
- Total Costs for Supplier,
- Common Optimized Values of the above stated parameters under the assumption that the supplier respects the customer's optimum values,
- Summary for customer and supplier including original costs, common optimized costs and their difference,
- Total Net Savings.

The main advantage of the developed application is not only the automatic derivation of the above stated results, but also the possibility to support a more advanced version of the *Cooperation Model*, according to which 3 stakeholders are involved in the procedure. As a result, the model that includes cooperation between Customer (Stakeholder1), and Supplier (Stakeholder 2) can be expanded to the following version:

- Customer (Stakeholder 1) - Supplier (Stakeholder 2),
- Customer (Stakeholder 3) - Supplier (Stakeholder 1).

It is, thus, obvious that in the new version of the initial model, Stakeholder 1 is considered as customer as well as supplier. The developed application supports both situations. The tool which was utilized for the

development of the currently presented platform is Visual Basic for Applications in Microsoft Excel 2013. The platform includes three UserForms. The first userform (fig1) is utilized as an input form for entering the essential data required for the above mentioned calculations. The individual input data are the followings: Q – total amount of the delivery; Cp1 – purchase price of customer per delivery; Cs1 – customer’s costs of storage for a period; Cp2 – sales price of supplier per delivery; Cs2 – supplier’s costs of storage for a period; T – time, period. Through the first input form, the user can select if the applied method will involve 2 or 3 stakeholders. If the user decides to proceed with a calculation for 3 stakeholders all the inactive fields (Cp3, Cs3 values) are activated.

**Figure 1.** Input data form of the Cooperation Model

The screenshot shows a window titled "COOPERATION MODEL" with a standard Windows title bar (minimize, maximize, close buttons). Inside the window, there are several input fields arranged vertically on the left side, each with a label to its left:
 

- Q: A text input field containing the number "1".
- Cp1: An empty text input field.
- Cs1: An empty text input field.
- Cp2: An empty text input field.
- Cs2: An empty text input field.
- Cp3: A text input field containing the number "0".
- Cs3: A text input field containing the number "0".
- T: An empty text input field.

 To the right of these fields, there is a checkbox labeled "PERFORM CALCULATION WITH 3 STAKEHOLDERS". Below the checkbox are two buttons: "CALCULATE" and "CANCEL". The window has a light gray background and a blue border.

Source: own

Through the second userform (fig 2.) all the derived calculations are automatically demonstrated. Again, depending on the number of stakeholders (2 or 3) some of the fields remain inactive with zero values. The second task performed through the userform is to decide, according to the derived results, if the cooperation is approved by none, all or 2 of the stakeholders. The specific task is performed by the optionbuttons which are depicted in fig.2. And the individual input data are the followings: Xopt1 – the optimal amount of a delivery for customer; Nc(Xopt1) – the optimal total costs for customer per delivery; Xopt2 – the optimal amount of a delivery for supplier; NC(Xopt1) – the optimal total costs for supplier per delivery; Nc2(Xopt1) – the actual costs for supplier (because in general the

supplier has to accept the customer's conditions in the contract between the business partners).

**Figure 2.** Optimum values for each stakeholder

The screenshot shows a software interface with the following data:

Stakeholder	Value
Xopt1	1870,83
Hc(Xopt1)	26191,60
Xopt2	5486,35
Hc(Xopt2)	54863,47
Xopt3	0
Hc(Xopt3)	0
Nc2(Xopt1)	89799,73
Hc3(Xopt1)	0
Nc(TOTAL)	115991,33

ESTIMATION OF COMMON VALUES AND NET TOTAL SAVING	
Xopt(com)	3818,81
Hc(Xopt(com))	91651,51
Nc1(Xopt(com))	33147,28
Nc2(Xopt(com))	58504,23
Nc3(Xopt(com))	0
DNc1	-6955,68
DNc2	31295,5
DNc3	0
Total Savings	24339,82

Source: own

Again depending on the decision of the user the inactive frame *ESTIMATION OF COMMON VALUES AND NET TOTAL SAVING* is activated, and accordingly some of the values remain inactive (Nc3(Xopt(com)), DNc3). These values refer to the positive or negative participation of the third stakeholder. The estimation of common values means the result of cooperation between business partners, in this case between customer and supplier of the delivery. Xopt(com) represents the optimal amount of the delivery when customer and supplier cooperate. Nc(Xopt(com)) means the total costs for the delivery. Nc1(Xopt(com)) and Nc2(Xopt(com)) are the values of customer's and supplier's total costs. The costs are divided based on the appropriate equations. DNc1 shows the result of the comparison of the original customer's costs and the new one and DNc2 shows the result of the comparison of the original supplier's costs and the new one. From DNc1 and DNc2 we can calculate the total savings. In this case, the customer has loss in this contract, and therefore the supplier has to reimburse the customer's loss. The total savings are divided between contract partners by the win – win rule.

**Figure 3.** Estimation of common optimized values and Net Total Savings according to the number of involved stakeholders

OPTIMUM VALUES FOR DELIVERIES AND COSTS FOR ALL INVOLVED STAKEHOLDERS

Xopt1	1870,83	Nc2(Xopt1)	89799,73
Nc(Xopt1)	26191,60	Nc3(Xopt1)	0
Xopt2	5486,35		
Nc(Xopt2)	54863,47		
Xopt3	0		
Nc(Xopt3)	0	Nc(TOTAL)	119991,33

NEW CALCULATION

COOPERATION APPROVED BETWEEN 2 STAKEHOLDERS

COOPERATION APPROVED BETWEEN 3 STAKEHOLDERS

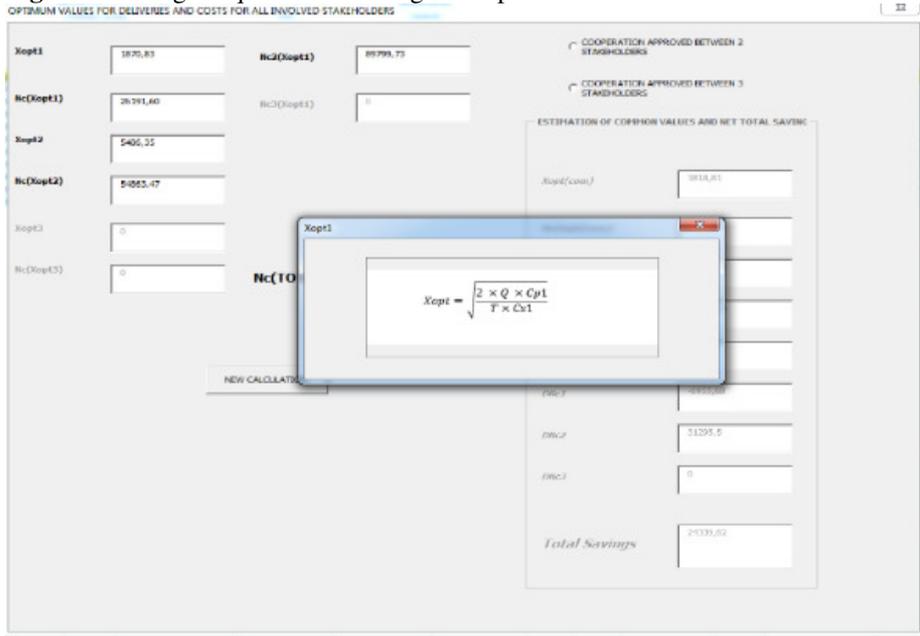
**ESTIMATION OF COMMON VALUES AND NET TOTAL SAVING**

Xopt(com)	3818,81
Nc(Xopt(com))	91651,51
Nc1(Xopt(com))	33147,28
Nc2(Xopt(com))	58504,23
Nc3(Xopt(com))	0
DNc1	-6955,68
DNc2	31295,5
DNc3	0
<b>Total Savings</b>	24339,82

Source: own

Finally, since the platform is designed for educational purposes, an additional possibility is supported. Through the second userform, and by moving the mouse pointer to the appropriate field, the user is able to view the mathematical equation which provides the corresponding result. The equation is stored in a third userform and according to the position of the mouse cursor, the corresponding image is loaded and the appropriate equation is visible by the user.

**Figure 4.** Emerged equation according to the position of the mouse cursor



Source: own

Figure 4 shows the basic equation for calculating the optimum quantity of delivery. It is the same formula for both the customer and the supplier. The difference is in the calculated values, namely purchase price per delivery and costs of storage for a period.

For calculating the total costs for calculated optimum quantity of delivery the following formula is used (from the customer's view):

$$N_c(x_{opt}) = \sqrt{2QTc_{p1}c_{s1}} \quad (1)$$

And the calculation of total costs from the supplier's view is as follows:

$$N_c(x_{opt}) = \sqrt{2QTc_{p2}c_{s2}} \quad (2)$$

Interesting is the fact that the supplier in general is not able to implement their optimum amount of the costs, because it is dependent on the specific customer respecting their terms. Therefore,

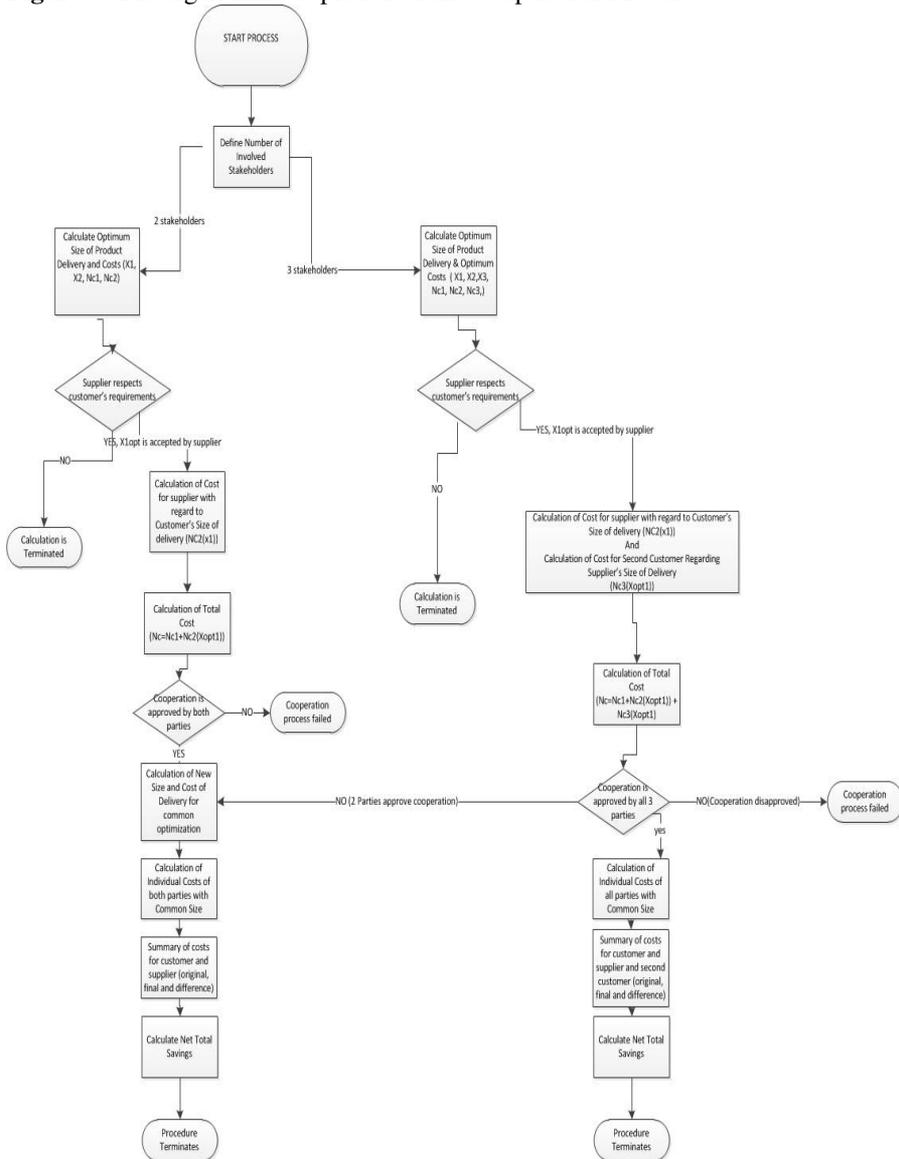
for the calculation of the total suppliers' costs the following formula is used:

$$N_c(x_{opt}) = \frac{Q}{x} c_{p2} + \frac{x \cdot T}{2} c_{s2} \quad (3)$$

Next, the optimal amount of delivery by common cooperation of business partners, total costs, costs allocation and a comparison of the results obtained are calculated. All formulas are displayed after moving the pointer to the appropriate field.

The algorithmic depiction of the Cooperation Model, which is supported by the currently delineated platform, is performed via the flowchart of fig 5.

**Figure 5.** The algorithmic depiction of the Cooperation Model



Source: own

The algorithmic steps which support the functionality of the developed application, are a crucial part of the present work. They are as follows:

- The operation of the software is initiated by importing the forms in an excel worksheet and running the application,

- Initially, the application prompts the user to define the number of stakeholders. After selecting the number of the involved stakeholders, the user inserts input values and the Optimum Size of product's delivery and cost are calculated,
- If the supplier respects the customer's requirements, then a calculation of size and cost of delivery and a calculation of cost for the supplier with regard to the customer's size of delivery is made. In the occasion when 3 stakeholders are involved, then, an additional calculation occurs, that is, the estimation of cost for the second customer with regard to the supplier's size of delivery. In a different case, the calculation process is terminated,
- The calculation of Total Cost is then performed,
- The next decision task is the approval of the cooperation by all parties, either 3 or 2. All calculations have been performed, but, the user is now prompted by the system to define the number of stakeholders that approve the cooperation,
- If the cooperation is rejected by all parties then the process is terminated. If all parties approve the cooperation, then the results of the calculation of individual costs are considered,
- Moreover, a summary of costs is controlled by the user,
- Total Net Savings in all the aforementioned cases are also determined and, then,
- The procedure is terminated.

## **Conclusions**

In the present article a simple application that can be used for the calculation of partnership efficiency is illustrated. Research shows that small and medium enterprises currently do not use complex software tools, but only spreadsheet programs, like Microsoft Excel. The current application developed by using the VBA programming language, can help small and medium enterprises in determining partnership efficiency.

Possible directions of future research could follow two ways. The first one, is to find out whether small and medium enterprises deal with the problem of partnership efficiency or other problems connected to stock management and whether they would be interested in applications like this one. The next possible way to follow (based on the research) would be to create applications for other models of the theory of stocks. For example for dynamic models with the movement of stocks absolutely determined, dynamic models with the movement of stocks determined probability completely, etc.

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