



---

# SELECTION OF CRITERIA FOR KEY PERFORMANCE INDICATORS BY THE MATRIX METHOD

**Lagodiienko Volodymyr**

Department of Marketing, Business and Trade, Odessa National Academy of Food Technologies, str. Kanatnaya 112, Odessa, Ukraine

**Malanchuk Marina**

Department of Economics and Financial Support, National University of Defense of Ukraine named after Ivan Chernyakhovsky, Povitroflotsky av. 28, Kyiv, Ukraine

**Gayvoronska Inna**

Department of Marketing and Business Administration, Odessa I.I.Mechnikov National University, Frantsuzs'kyi bul'var 24/26, Odessa, Ukraine

**Sedikov Denys**

Department of Management and Logistics, Odessa National Academy of Food Technologies, str. Kanatnaya 112, Odessa, Ukraine)

## ABSTRACT

*An enterprise for successful competition on the market needs to carry out detailed monitoring of the company's activities in strategic focus, increase the efficiency and effectiveness of management decisions, control the most important financial and non-financial performance indicators (KPIs) that are targeted for the company, and whose degree of achievement determines the movement of the enterprise according to a given strategy. . The values of KPI reflect both the business performance in general and the business processes that are considered separately, structural units and human resources. The article proposed matrix method of optimizing the portfolio of products to determine the main KPI. Also, on illustrative practical examples authors suggest Strategic map (fragment) and KPIs matrices of the key employees of a company.*

**Keywords:** key performance indicators, KPI, matrix method, project management.

**Cite this Article:** Lagodiienko Volodymyr, Malanchuk Marina, Gayvoronska Inna and Sedikov Denys. Selection of criteria for key performance indicators by the matrix method, *International Journal of Mechanical Engineering and Technology*, 10(1), 2019, pp. 1303-1311.

<http://www.iaeme.com/IJMET/issues.asp?JType=IJMET&VType=10&IType=1>

---

## 1. INTRODUCTION

The organization's strategy, the definition of its goals and objectives is the privilege and responsibility of the highest management of the organization, while the implementation of the strategy is to the employees of the organization at the level of structural units [1]. Significant danger to the organization's development is the lack of information exchange between its management and employees. This is due, primarily, to the information congestion of the management, which prevents the ability to adequately assess the information and, as a consequence, makes it impossible to monitor the implementation of personnel strategic objectives. However, the lack of a specific strategic goal for the staff and the appropriate system of motivation leads to the fact that the executives do not coordinate their actions with the global goal of the organization and have no opportunity to orientate themselves in strategic directions. Such "disorientation" often leads to the cost of resources for the organization to perform secondary tasks. This problem is typical of many large state organizations with a complex structure both in Ukraine and abroad [2-5].

Thus, the definition of performance and efficiency indicators is still relevant, moreover, due to global data society data is becoming increasingly acute issue of their automation

## 2. KEY PERFORMANCE INDICATORS (KPI)

Key performance indicators (KPI) – are indicators of the activities of the unit (enterprise), which helps the organization in achieving strategic and tactical (operational) goals. The use of key performance indicators gives the organization the opportunity to assess their condition and help assess the implementation of the strategy.

Key performance indicators allow to evaluate the effectiveness of actions performed. They can be used both to evaluate the work of the entire company, its individual divisions and specific employees [3]. With the help of the KPI system, CEOs can not only monitor and evaluate the effectiveness of the actions performed, but also build an effective wage system. The condition of the indicator is the possibility of its measurement.

There are ideal and actual KPIs. Ideal should be high, but at the same time quite achievable, so as not to cause frustration among employees. Bonuses / bonuses are awarded if the actual as close as possible to the ideal. The number of metrics should not be very large, otherwise they are difficult to control and develop an honest system of material motivation, which would take into account all the metrics [6].

Also, KPIs are delayed and operational. The first show the results of work for a certain period, the second - the current situation. They allow to manage the situation within a certain period of time in order to get the expected result at the end of the reporting period. In order to correctly interpret the data, the cuts must be regular, the number of measurements is adequate. They should not be too much. Experts agree that the younger the company, the more control is needed for stable growth, respectively, the more often you need to take measurements.

The following types of key indicators are distinguished [7-8]:

- KPI result - how much and what result produced;
- KPI cost - how much resources were spent;
- KPI functioning - performance indicators of business processes (allows you to assess the compliance of the process with the required algorithm for its implementation);
- KPI performance - derived indicators characterizing the relationship between the result and the time spent on its receipt;
- Efficiency KPIs (performance indicators) are derived indicators that characterize the ratio of the result obtained to the cost of resources.

## Selection of Criteria for Key Performance Indicators by the Matrix Method

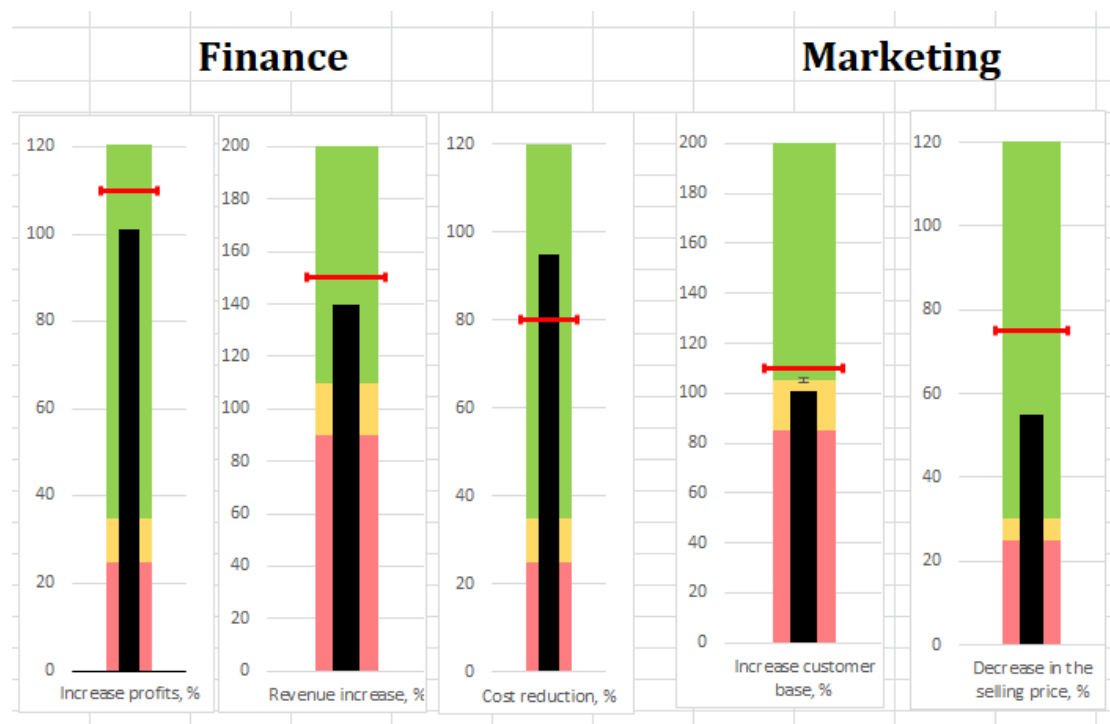
When developing process indicators, the following rules should be followed:

- A set of indicators should contain the minimum required number of them to ensure the full management of the business process;
- Each indicator must be measurable;
- The cost of measuring the indicator should not exceed the managerial effect of the use of this indicator.

KPI is very different from the fields of activity of the enterprise and from the objectives of the enterprise. So, several specific tasks are traditionally relevant for production companies:

- Product cost management;
- Monitoring productivity;
- Fight against marriage.

In Figure 1, we depict a fragment of a strategic map of a manufacturing company, which made the struggle to increase production efficiency the focus of its strategy. In financial terms, this is reflected in the reduction of production costs.



**Figure 1** Strategic map (fragment)

At the same time, the company hopes that cost reduction will allow to become a leader in costs and reduce selling prices. This will give an advantage over competitors, lead to an increase in total sales and expand the customer base.

These two market objectives are set in a marketing perspective. Thus, the strategy takes on a consistent and solid look, it is compact and focused.

Improving the efficiency of the production process is reflected in the grid of goals at the levels of business processes and resources.

Increased productivity will be achieved through:

- reduce downtime;
- reducing the volume of marriage;

- reduce equipment breakdowns;

Downtime will be reduced due to:

- reduce equipment breakdowns;
- more accurate planning of inventory, which is planned to introduce an automated inventory management system.

At the same time, the cost of production should be reduced by conducting a more efficient procurement policy; for this, it is planned to organize a tender department.

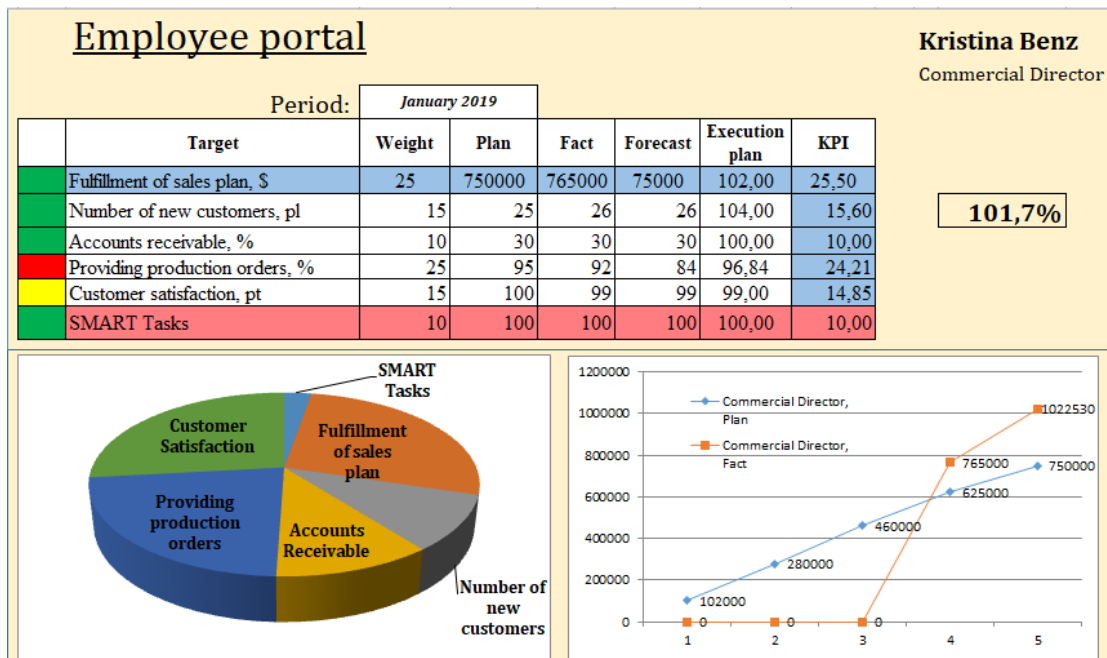
Thus, it is seen that none of the goals “sags”, but is in a chain of interconnections to achieve the goals of the top level.

Also the important moment, the company considers the optimization of *its product portfolio*, which will make it possible to abandon inefficient ones and focus on the “stars”.

For the evaluation of personnel on key performance indicators for each employee of the organization, an agreement on goals or a “KPI matrix” is formed. In this matrix, we include a limited number of indicators from the KPI library posts. Four to five indicators for employees are usually recommended, six to seven indicators for managers at various levels. In practice, KPI matrices have different forms and contents. When developing such matrices, it is important to observe a compromise between the completeness of the information necessary for setting goals and conducting an assessment, on the one hand, and their simplicity and clarity for employees - on the other.

Let's look at the performance matrix of key employees.

In the matrix of the *Commercial Director* (fig. 2), it should be paid special attention to the indicator “production downtime due to the lack of orders”. This indicator is strategic, as it helps to reduce production downtime, although it does not seem to relate directly to the activities of the sales department.



**Figure 2** KPIs matrix of the Commercial Director

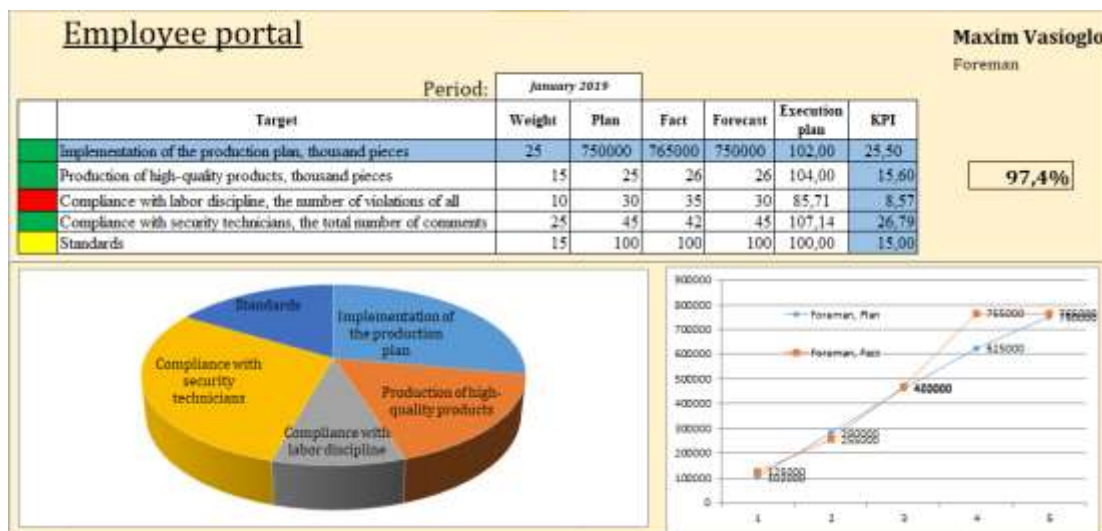
When coordinating goals across horizontally, it is very important not to miss those output parameters of a department / business process that provide high-quality input for the next unit / business process.

## Selection of Criteria for Key Performance Indicators by the Matrix Method

In this case, it is important for us not only the fulfillment of the plan for the revenue for the period, but the distribution of orders in such a way that production is always loaded.

It is these “stitching” indicators that, unfortunately, are most often forgotten when designing KPIs, which greatly reduces the effectiveness and efficiency of the target management system of an enterprise.

*Foreman* (fig. 3). The foreman has more power and resources. Therefore, its matrix is more result-oriented.



**Figure 3** KPIs matrix of the Foreman

Such cards should be compiled for all key employees of the enterprise.

### 3. MATRIX METHOD OF OPTIMIZING THE PORTFOLIO OF PRODUCTS FOR THE MAIN KPI

In order to find a solution to an antagonistic game (an antagonistic game is a non-cooperative game in which two players participate, the winnings of which are opposite), it is necessary to determine the optimal strategies of the players and the price of the game. The maximin and minimax strategies  $i, j$  corresponding to the price of the game are the optimal strategies of the first and second players, and their combination is the decision of the game.

An equilibrium situation can arise in a game when each player chooses his optimal strategy – maximin and minimax – and receives respectively his maximum guaranteed gain and minimum guaranteed loss, the values of which coincide and the levels of the value of game  $V$ .

If there is a situation of equilibrium in the game, then its solutions possess stamina, since it is not beneficial for any of the players to deviate from this situation and apply a different strategy that differs from the optimal one. A pair of pure strategies  $(h, j)$  creates an equilibrium situation in the game if and only then when the element  $h$  and,  $j$  exists in the payoff matrix, which is both the largest in its column and the smallest in its row. This element (if it exists) is called the saddle point (by analogy with the surface of the saddle, which curves down in one direction and up, in the other).

Consider this method on a specific example. Assume that the company can produce four types of products:  $A_1, A_2, A_3, A_4$  to obtain profit. Its value depends on the state of demand, which can be in one of three possible states:  $B_1, B_2, B_3$ .

**Table 1** The profit of the enterprise in different states of demand

Types of products	Possible state of demand		
	B1	B2	B3
A1	4	2	2
A2	2	5	0
A3	0	2	5
A4	3	1	1

Elements of the matrix  $H' = \| h_{ij} \|$  characterize the amount of profit that the company will receive if it produces the  $i$ -th product type ( $i = 1,2,3,4$ ) at the  $j$ -th demand state ( $j = 1,2,3,4$ ). It is necessary to determine the optimal proportions of the types of products manufactured by the enterprise and the sale of which would provide it with the maximum possible revenue from the state of demand.

Since the task is reduced to an antagonistic game, then in this case, the enterprise is the first player is, and as the second – nature, which affects the state of demand. In this case, the conflict between the two parties can be characterized as antagonistic, and using the model of this conflict allows the enterprise to estimate the profit it can receive regardless of the state of demand.

Acting as the first player, the company can use four strategies:

1. the first pure strategy, corresponding to the release of the company only A1 products;
2. the second clean strategy, corresponding to the release of the enterprise only A2 products;
3. the third clean strategy, corresponding to the release of the enterprise only A3 products;
4. the fourth net strategy, corresponding to the release of the company only A4 products.
5. Speaking as a second player, nature can use three possible strategies:
6. the first pure strategy in which the state of demand B1 is realized;
7. the second pure strategy in which the state of demand B2 is realized;
8. the third net strategy in which the state of demand B3 is realized.

Set the payment matrix  $H$  of this game:

$$H' = \begin{pmatrix} 4 & 2 & 2 \\ 2 & 5 & 0 \\ 0 & 2 & 5 \\ 3 & 1 & 1 \end{pmatrix}$$

Analysis of the payment matrix shows that the first strategy of the first player dominates over its last – fourth strategy (each of the elements of the first row of the matrix is greater than the corresponding element of the last row of the matrix), therefore, the credibility of the fourth strategy used by the first player is zero. From the analysis performed, it turns out that the dimension of the matrix  $H$  can be reduced by removing the fourth row from it, as a result, the payment matrix can be reduced to the matrix  $H$ :

$$H = \begin{pmatrix} 4 & 2 & 2 \\ 2 & 5 & 0 \\ 0 & 2 & 5 \end{pmatrix}$$

Check if this game has a saddle point. Find the top and bottom price of the game:

## Selection of Criteria for Key Performance Indicators by the Matrix Method

$$V^{\wedge} = \max_i \min_j h_{ij} = 2$$

$$V^{\vee} = \min_j \max_i h_{ij} = 2$$

Since the lower price of the game is not equal to the top, this antagonistic game does not have a saddle point; therefore, its solutions should be sought in mixed strategies.

We reduce this antagonistic conflict to a direct and double linear programming problem.

<b>The task of the second player</b>	<b>The task of the first player</b>
<i>Objective function</i>	
$F_{(x)} = x_1 + x_2 + x_3 \rightarrow \max$	$Z_{(y)} = y_1 + y_2 + y_3 \rightarrow \min$
<i>Functional limitations</i>	
$4x_1 + 2x_2 + 2x_3 \leq 1$	$4y_1 + 2y_2 \geq 1$
$2x_1 + 5x_2 \leq 1$	$2y_1 + 5y_2 + 2y_3 \geq 1$
$2x_2 + 5x_3 \leq 1$	$2y_1 + 5y_3 \geq 1$
<i>Direct restrictions</i>	
$x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$	$y_1 \geq 0, y_2 \geq 0, y_3 \geq 0$

Using the simplex method to solve the problem of the first player, we get:

$$Y^* = \left( y_1^* = \frac{9}{88}; y_2^* = \frac{14}{88}; y_3^* = \frac{12}{88} \right),$$

$$Z(y^*) = y_1^* + y_2^* + y_3^* = \frac{35}{88}$$

From the ratio of  $y_1^* + y_2^* + y_3^* = \frac{1}{V}$ , we find V

$$V = \frac{1}{y_1^* + y_2^* + y_3^*} = \frac{88}{35}$$

From the ratio

$$y_1^* = \frac{p_1^*}{V}; y_2^* = \frac{p_2^*}{V}; y_3^* = \frac{p_3^*}{V}$$

Find:

$$p_1^* = y_1^* * V = \frac{9}{88} * \frac{88}{35} = \frac{9}{35}$$

$$p_2^* = y_2^* * V = \frac{14}{88} * \frac{88}{35} = \frac{14}{35}$$

$$p_3^* = y_3^* * V = \frac{12}{88} * \frac{88}{35} = \frac{12}{35}$$

Thus,

$$P^* = (p_1^* = \frac{9}{35}; p_2^* = \frac{14}{35}; p_3^* = \frac{12}{35}; p_4^* = 0)$$

Based on the solution that was found for the double linear programming problem, we find the solution to the basic problem, then:

$$X^* = \left( x_1^* = \frac{19}{88}; x_2^* = \frac{6}{88}; x_3^* = \frac{10}{88} \right)$$

$$q_1^* = x_1^* V = \frac{19}{88} * \frac{88}{35} = \frac{19}{35}$$

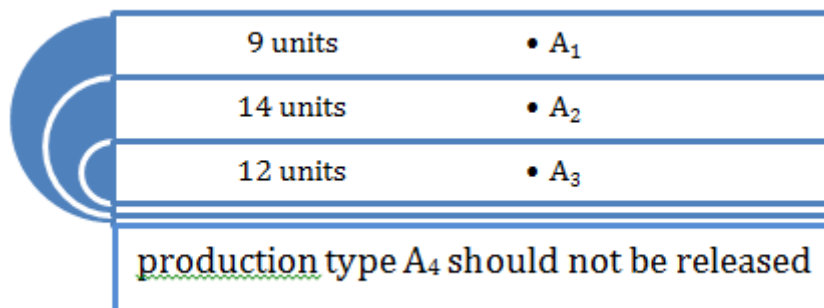
$$q_2^* = x_2^* V = \frac{6}{88} * \frac{88}{35} = \frac{6}{35}$$

$$q_3^* = x_3^* V = \frac{10}{88} * \frac{88}{35} = \frac{10}{35}$$

$$q_4^* = 0$$

$$Q^* = \left( q_1^* = \frac{19}{35}; q_2^* = \frac{6}{35}; q_3^* = \frac{10}{35}; q_4^* = 0 \right)$$

The obtained optimal mixed strategy of the first player should be interpreted as follows: from the total volume of production, which is 35 units, the enterprise should release:



**Figure 4** Optimized product portfolio

When applying its optimal strategy, the revenue that a company can receive, regardless of the state of demand, will be at least 2.5 million \$.

#### 4. CONCLUSION

An important advantage of this approach is that matrix methods are relatively easy to automate, which, with large volumes of accumulated information, becomes of great significance.

The proposed method allows for certain criteria to select the necessary indicators for further study. The economic interpretation of various aspects of the results of managerial analysis obtained during the calculation of indicators is based on an integrated factor model for assessing the efficiency of the enterprise, and the visualization of the results of the analysis of indicators is carried out using such a tool as a managerial monitor.

#### REFERENCES

- [1] Svitlana Bondarenko, Volodymyr Lagodiienko, Iryna Sedikova and Olga Kalaman, Application of Project Analysis Software in Project Management in the Pre-Investment Phase, *Journal of Mechanical Engineering and Technology*, 9(13), 2018, pp. 676-684
- [2] Svitlana Anatoliivna Bondarenko, Igor Ivanovych Savenko, Iryna Oleksandrivna Sedikova and Kateryna Volodymyrivna Kucherenko. The ranking of the level of



- remuneration as a motivational mechanism. *International Journal of Civil Engineering and Technology*, 9(11), 2018, pp. 1384-1394.
- [3] M. V. Bogatyreva, N. V Matveev. KPI as market surrogate. *The European Proceedings of Social & Behavioural Sciences*, 2018, pp. 230-238 <https://dx.doi.org/10.15405/epsbs.2018.12.29>
- [4] Bashynska, I., Filippov, V., and Novak, N. Smart Solutions: Protection NFC Cards With Shielding Plates. *International Journal of Civil Engineering and Technology*, 9(11), 2018, pp. 1063-1071.
- [5] Bashynska I., Dyskina A. The overview-analytical document of the international experience of building smart city. *VERSLAS: TEORIJA IR PRAKTIKA / BUSINESS: THEORY AND PRACTICE*, 19, 2018, pp. 228–241 <https://doi.org/10.3846/btp.2018.23>
- [6] Victoria Lakiza, Isabelle Deschamps. How to Develop Innovation KPIs in an Execution-Oriented Company. *Technology Innovation Management Review*, (Volume 8, Issue 7), 2018, pp. 14-30
- [7] Osama Mohamed Ahmed Adam and Isam Mohammed Abdel-Magid. Key Performance Indicators for Integrated Water Resources Management in Some African Countries. *SUST Journal of Engineering and Computer Science (JECS)*, Vol. 16, No. 2, 2015, pp. 50-60
- [8] Svitlana Bondarenko, Iryna Liganenko, Olga Kalaman and Liubov Niekrasova, Comparison of Methods For Determining The Competitiveness of Enterprises To Determine Market Strategy, *International Journal of Civil Engineering and Technology (IJCIET)* 9(13), 2018, pp. 890–898.