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INTEGRAL METHOD FOR DETERMINING THE KEY VALUE ITEM GROUP

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In this paper, we consider the problem on constructing a mathematical model of the pricing system for retail companies based on the identification of a key value item group of products. The methods of calculating key value item indicators are proposed for further use in dynamic pricing systems based on data on sales of products, revenue received from each product, availability of products provided by competitors at the market, and assessment of correlation between products viewed in consumer baskets. Based on the described methods, we propose a formula for combining a set of methods using an integral method. The goal of this method is to use coefficients to adapt the key value item calculation for individual company development strategies. For the developed methods, we consider a computational example and give conclusions that demonstrate the identification of a key value item group of products for retail companies.

Keywords: KVI; method; determing; price; product; integral method.

Introduction

For the purpose of effective competition, each retailer allocates key value items [1], abbreviated as KVI [2]. These products allow customers to form an opinion about what the company specializes in and why the company is better than other retailers. Many approaches are used to determine the KVI in accordance with the development strategy of each company [3]. However, taking into account that most companies follow the same development strategies, we can say that these companies have identical or similar algorithms for determining the KVI of products [1]. In order to automate the process of determining and redetermining key products, retailers have developed appropriate methods [4, 5] used in pricing systems. The aim of the paper is to construct an integral method for determining the KVI of a product that covers the most common development strategies of companies with the possibility of further application in software engineering to create an appropriate module in the dynamic pricing system.

1. Definitions

By the KVI indicator of a product we mean a coefficient, which takes values from 0 to 1 and reflects significance of the product for the company. From the viewpoint of the company, the key product is the product whose KVI indicator is closest to 1. Depending on the applied development strategy, different methods of calculating the KVI indicator are used.

2. Preliminary Methods for Determining KVI of Product

2.1. Method Based on Demand for Product

For the company, the most significant product is the product with the most units sold during the analyzed period. Then, the KVI indicator for the i-th product is calculated as

$$KVI_i = \frac{Q_i}{\sum\limits_{j=1}^{n} Q_j},$$

where n is the number of types of products, Q_i is the amount of sales of the i-th product for the analyzed period, $i = 1, 2 \dots n$.

2.2. Method Based on Product Generating the Most Revenue

In this case, the total revenue for all products is considered to be 1. Then, the KVI indicator for the i-th product is calculated as

$$KVI_i = \frac{Q_i \cdot P_i}{\sum\limits_{j=1}^{n} (Q_j \cdot P_j)},$$

where P_i is the price of the i-th product, $i = 1, 2 \dots n$.

2.3. Method Based on Exclusivity of a Product at Market

In order to unify the calculation of this method for all other methods, we consider the range from 0 to 1, where the value 1 is associated with the product, which is unique at the market, i.e. the considered competitors can not provide such a product, and the value 0 is associated with a product that all other considered competitors provide. Then, the KVI indicator for the i-th product is calculated as

$$KVI_i = 1 - \frac{l_i}{m},$$

where l_i is the number of the considered competitors that provide the i-th product, $i = 1, 2 \dots n$, and m is the total number of the considered competitors.

2.4. Method Based on Evaluation of Correlation of a Product With Other Products in Customer Baskets

In this case, KVI reflects the frequency of the product presence in each customer basket for a certain period. Then, the KVI indicator for the i-th product is calculated as

$$KVI_i = \frac{\sum\limits_{j=1}^{n} \frac{Q_{ij}}{Q_j}}{n},$$

where n is the number of all types of products in the considered baskets, Q_{ij} is the number of times when the i-th product was sold in the same basket as the j-th product, Q_j is the number of times when the j-th product was sold.

3. Integral Method for Determining KVI of Product

In the framework of individual company development strategies, we can consider a situation when, in order to determine significance of a product, it may be necessary to use several methods of calculating the KVI indicator at the same time. Then, the total KVI indicator for the i-th product is calculated as

$$KVI_i^{total} = \sum_{j=1}^{k} a_j \cdot KVI_j,$$

where a_j is the parameter that takes values from 0 to 1, satisfies the condition $\sum\limits_{j=1}^{k} a_j = 1$, and shows the level of significance of the j-th method in the total number of factors, while KVI_j is the result of the j-th method for calculating the indicator, and k is the number of the used methods.

The block diagram of the integral method is shown in Fig. 1.

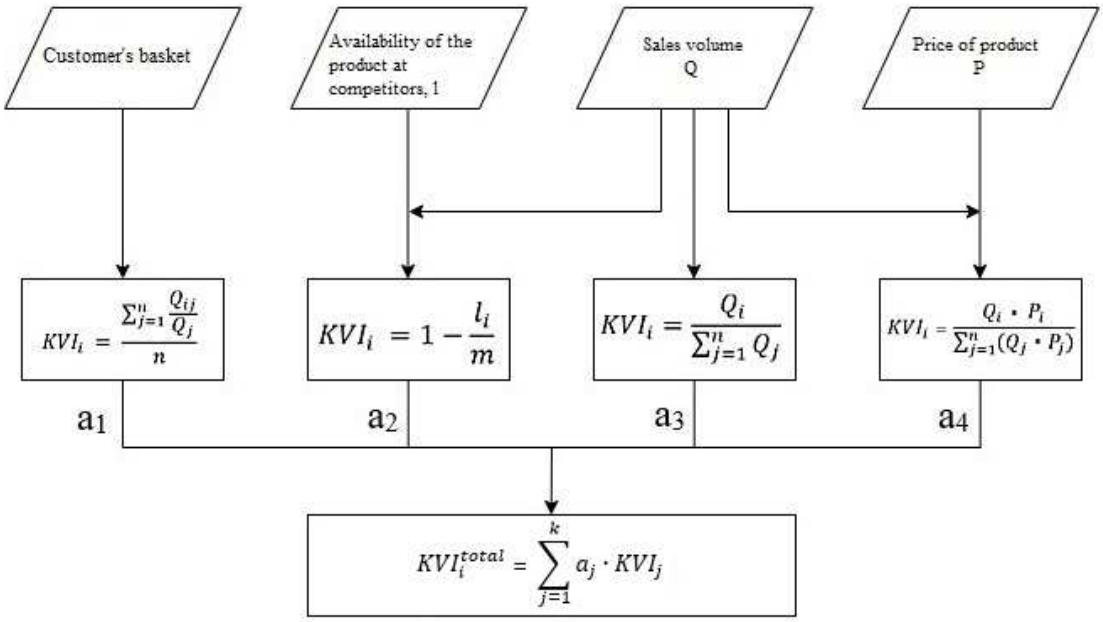

Fig. 1. Block diagram of the integral method for calculating the KVI indicator

The value of a_j is determined in accordance with the level of significance of the company's j-th method against the background of others. Note that solution to the problem on parametric optimization of the KVI indicator allows to determine the optimal strategy for the company's development.

The integral method is universal, therefore, the method allows to adapt to various data available to the company.

4. Computational Example

As an example, apply the integral method in the case of a company which has sales data for 5 different products shown in Table 1.

Table 1

Data on sales of products

№ of product	Amount of product sold, units	Price of product, RUB
1	1830	210.6
2	980	230.9
3	2100	75.5
4	1650	115.2
5	1200	450.5

Based on the current data set, the KVI indicator can be calculated by demand and revenue. The calculation results are shown in Table 2.

Table 2

Result of calculating KVI indicators by demand and by revenue

№ of Product	KVI indicator by demand	KVI indicator by revenue
1	0.235825	0.256776
2	0.126289	0.150763
3	0.270619	0.105636
4	0.212629	0.126643
5	0.154639	0.360181

Based on the obtained results, it is easy to see that Product № 3 and Product № 5 has the largest KVI indicator calculated by demand and revenue, respectively.

In addition, consider information about the availability of products provided by competitors, see Table 3, and information about customer baskets for the last period, see Table 4.

Table 3

Availability of products provided by competitors

	Pr. № 1	Pr. № 2	Pr. № 3	Pr. № 4	Pr. № 5
Competitor № 1	+	-	-	+	-
Competitor № 2	+	+	+	-	-
Competitor № 3	+	+	+	-	-
Competitor № 4	+	-	-	+	-
Competitor № 5	+	+	-	-	+
Competitor № 6	+	+	+	-	-
Competitor № 7	+	-	-	-	+
Competitor № 8	-	-	+	-	-
Competitor № 9	+	-	-	+	-
Competitor № 10	-	-	+	-	+

Based on the data given in Table 4, we construct the matrix that reflects the number of pairs of product combinations for calculating the KVI indicator based on the correlation evaluation (Table 5).

Table 4

Availability of products in customer baskets

	Pr. № 1	Pr. № 2	Pr. № 3	Pr. № 4	Pr. № 5
Basket № 1	+	-	-	+	-
Basket № 2	-	-	+	-	+
Basket № 3	-	+	-	-	-
Basket № 4	-	-	-	-	-
Basket № 5	+	-	-	+	-
Basket № 6	-	-	+	-	-
Basket № 7	+	+	-	+	-
Basket № 8	-	-	+	-	+
Basket № 9	-	+	-	-	-
Basket № 10	+	-	-	+	-

Table 5

Matrix of the number of product pairs encountered in customer baskets

	Pr. № 1	Pr. № 2	Pr. № 3	Pr. № 4	Pr. № 5
Product № 1	-	1	0	4	0
Product № 2	1	-	0	1	0
Product № 3	0	0	-	0	2
Product № 4	4	1	0	-	0
Product № 5	0	0	2	0	-

Let us calculate KVI indicators based on uniqueness of the product at the market and on correlation evaluation for each product, respectively. The results are presented in Table 6.

Table 6

Result of calculating KVI indicators by uniqueness and by correlation evaluation

№ of Product	KVI indicator by uniqueness	KVI indicator by correlation evaluation
1	0.20	0.25
2	0.60	0.13
3	0.50	0.13
4	0.70	0.25
5	0.70	0.20

Based on the obtained results, it is easy to see that Product № 4 and Product № 5 have the largest KVI indicator calculated by uniqueness of a product, while Product № 1 and Product № 4 have the largest KVI indicator calculated by correlation evaluation.

In order to apply the integral method to determine the KVI indicator based on the totality of the obtained results, it is necessary to determine the values of each parameter a_j, where a_j is the parameter that takes values from 0 to 1, satisfies the condition $\sum_{j=1}^{k} a_j = 1$. Taking into account the restrictions, we determine the values of a_j based on how many times and which of the KVI methods give the highest significance. To this end, we construct

a rating of methods for each product. Namely, associate the method that gives the lowest KVI with a rating "1", then set the ratings in accordance with the increasing value of KVI and calculate a_j as the sum of the method ratings divided by the total rating of all methods (Table 7).

Table 7

Rating of KVI indicator calculation methods to calculate the index a_j

	Method № 1	Method № 2	Method № 3	Method № 4
Product № 1	2	4	1	3
Product № 2	1	3	4	2
Product № 3	3	1	4	2
Product № 4	2	1	4	3
Product № 5	1	3	4	2
Sum of ratings	9	12	17	12
Index a_j	0.18	0.24	0.34	0.24

Calculate KVI_i^{total}, $i = 1, 2, \ldots, 5$, for each product by substituting the obtained values a_j:

$$KVI_1^{total} = 0.18 \cdot 0.235825 + 0.24 \cdot 0.256675 + 0.34 \cdot 0.20 + 0.24 \cdot 0.25 = 0.2320505,$$
$$KVI_2^{total} = 0.18 \cdot 0.126289 + 0.24 \cdot 0.150763 + 0.34 \cdot 0.60 + 0.24 \cdot 0.13 = 0.29411514,$$
$$KVI_3^{total} = 0.18 \cdot 0.270619 + 0.24 \cdot 0.105636 + 0.34 \cdot 0.50 + 0.24 \cdot 0.13 = 0.27526406,$$
$$KVI_4^{total} = 0.18 \cdot 0.212629 + 0.24 \cdot 0.126643 + 0.34 \cdot 0.70 + 0.24 \cdot 0.25 = 0.36666754,$$
$$KVI_5^{total} = 0.18 \cdot 0.154639 + 0.24 \cdot 0.360181 + 0.34 \cdot 0.70 + 0.24 \cdot 0.20 = 0.40027846.$$

As a result of calculating the KVI indicator by the integral method based on the level of significance of the methods, it turned out that Product №5 is the most important for the company than other products. Parameters a_j can be determined depending on the significance of the i-th strategy for the company rather than by calculation.

Conclusion

In this paper, we present the integral method of calculating the KVI indicator that covers most of the development strategies of retail companies, allows to evaluate the significance of products based on various factors, and makes it possible to calculate the indicator from the viewpoint of significance of both an independent development strategy and the totality of the strategies. Also, the proposed integral method allows to obtain KVI indicators in the absence of some of the original data.

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ИНТЕГРАЛЬНЫЙ МЕТОД ОПРЕДЕЛЕНИЯ КЛЮЧЕВОЙ ГРУППЫ ТОВАРОВ

Н. А. Панченко, А. К. Богушов

Рассматривается задача построения математической модели системы ценообразования для ритейлерских компаний, основанная на выявлении ключевой группы товаров. Предложены способы расчета ключевой группы товаров с целью дальнейшего использования в рамках систем динамического ценообразования, на основе данных о продажах товаров, выручке, полученной с каждого товара, наличия товаров у конкурентов на рынке, оценке корреляции между товарами, рассматриваемыми в потребительских корзинах. На основе описанных методов предложена формула расчета, объединяющая совокупность методов с помощью интегрального метода, целью которого является, с помощью коэффициентов, адаптировать расчет ключевой группы товаров для индивидуальных стратегий развития компании. Для разработанных методов рассмотрен вычислительный пример и приведены выводы, демонстрирующие определение ключевой группы товаров для ритейлерских компаний.

Ключевые слова: KVI; метод; определение; цена; товар; интегральный метод.

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