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; determining; 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

\[
KVI_i = \frac{Q_i}{\sum_{j=1}^{n} Q_j},
\]

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, \(i = 1, 2 \ldots n\).

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

\[
KVI_i = \frac{Q_i \cdot P_i}{\sum_{j=1}^{n} (Q_j \cdot P_j)},
\]

where \(P_i\) is the price of the \(i\)-th product, \(i = 1, 2 \ldots n\).

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, \(i = 1, 2 \ldots n\), 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

\[
KVI_i = \frac{\sum_{j=1}^{n} Q_{ij}}{Q_i},
\]

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

$$KV_{I_{total}}^{i} = \sum_{j=1}^{k} a_j \cdot KV_{I_j},$$

where $a_j$ is the parameter that takes values from 0 to 1, satisfies the condition $\sum_{j=1}^{k} a_j = 1$, and shows the level of significance of the $j$-th method in the total number of factors, while $KV_{I_j}$ 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.

![Block diagram of the integral method for calculating the KVI indicator](image)

**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

| Basket № | 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

| Product № | 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

| № 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).

| Rating of KVI indicator calculation methods to calculate the index $a_j$ |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Product № 1                      | Method № 1      | Method № 2      | Method № 3      | Method № 4      |
| 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 $KV I_i^{\text{total}}$, $i = 1, 2, \ldots, 5$, for each product by substituting the obtained values $a_j$:

$KV I_1^{\text{total}} = 0.18 \cdot 0.235825 + 0.24 \cdot 0.256675 + 0.34 \cdot 0.20 + 0.24 \cdot 0.25 = 0.2320505,$
$KV I_2^{\text{total}} = 0.18 \cdot 0.126289 + 0.24 \cdot 0.150763 + 0.34 \cdot 0.60 + 0.24 \cdot 0.13 = 0.2941154,$
$KV I_3^{\text{total}} = 0.18 \cdot 0.270619 + 0.24 \cdot 0.105636 + 0.34 \cdot 0.50 + 0.24 \cdot 0.13 = 0.2752646,$
$KV I_4^{\text{total}} = 0.18 \cdot 0.212629 + 0.24 \cdot 0.126643 + 0.34 \cdot 0.70 + 0.24 \cdot 0.25 = 0.36666754,$
$KV I_5^{\text{total}} = 0.18 \cdot 0.154639 + 0.24 \cdot 0.360181 + 0.34 \cdot 0.70 + 0.24 \cdot 0.20 = 0.40027846.$

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.

References

1. [Pricing in Trade. Indicator Products, Own Brand and First-Price Products], available at: https://insoret.ru/pricing/ (accessed on March 24, 2020). (in Russian)

2. [Marketing Dictionary: KVI], available at: https://www.marketch.ru/marketing_dictionary/marketing_terms_k/kay-vie-ai-kvi/ (accessed on March 24, 2020). (in Russian)
3. Algorithmic Pricing, Part II: AI and Pricing Strategy, available at: https://blog.griddynamics.com/algorithmic-pricing-part-ii-ai-and-pricing-strategy/ (accessed on March 24, 2020).

4. [How KVI Positions Help Retailers Increase Sales] available at: https://competera.ru/resources/articles/kvi-pricing (accessed on March 24, 2020). (in Russian)

5. Kilroy T., MacKenzie I., Manacek A. Pricing in Retail: Setting Strategy. KVCs and KVIIs in the New Digital Retail Era. Retail Practice, 2015, issue 4, pp. 1–10.

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Received May 23, 2020.

УДК 51-7 DOI: 10.14529/jcem200205

ИНТЕГРАЛЬНЫЙ МЕТОД ОПРЕДЕЛЕНИЯ КЛЮЧЕВОЙ ГРУППЫ ТОВАРОВ

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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 совокупности 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.

Литература

1. Ценообразование в торговле. Товары-индикаторы, СТМ и товары первой цены [Электронный ресурс]. – URL: https://insoret.ru/pricing/ (дата обращения: 24.03.2020).
2. Маркетинговый словарь: KVI [Электронный ресурс]. – URL: https://www.marketch.ru/marketing_dictionary/marketing_terms_k/kay-vie-ai-kvi/ (дата обращения: 24.03.2020).

3. Algorithmic Pricing, Part II: AI and Pricing Strategy [Электронный ресурс]. – URL: https://blog.griddynamics.com/algorithmic-pricing-part-ii-ai-and-pricing-strategy/ (дата обращения: 24.03.2020).

4. Как KVI-позиции помогают ритейлерам увеличивать продажи [Электронный ресурс]. – URL: https://competera.ru/resources/articles/kvi-pricing (дата обращения: 24.03.2020).

5. Kilroy, T. Pricing in Retail: Setting Strategy. KVCs and KVIS in the New Digital Retail Era / T. Kilroy, I. MacKenzie, A. Manacek // Retail Practice. – 2015. – Iss. 4. – P. 1–10.

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Поступила в редакцию 23 мая 2020 г.