RESEARCH ARTICLE

A New Framework for Food Catering Price Determination

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ABSTRACT

This article aims to propose a reasonable quantitative (mathematical) expressions for the price calculation of food-manufacturing products. Little research has been conducted on the validity of food product pricing; thus we have identified a need for a thorough, systematic investigation in this area. The suggested three methods are also applicable for developing the artificial intelligence system to solve raw food material (resources) quantity management and other inventory issues in collaboration with the food suppliers. We consider the option of an appropriate pricing strategy in the profit-making catering and other food production firms to be a relevant scientific issue, which we have have addressed and proposed solutions for in this article. By analyzing different scientific assumptions and attitudes, informed quantitative decisions were made. We also developed and described quantitative expressions for determining the price of food products using mathematical formulas. Also, we found that a simple three-digit rule, based on logic and proportional modeling of actions, as the main instrument is the most effective approach for formulating these pricing models. Original and innovative mathematical methods for the price accounting of food production have been created and explained. We have also explained how each of the three suggested methods works, along with their advantages and disadvantages in certain situations. Using these recommended methods of pricing will allow food companies to achieve more appropriate commercial results and to make less expenditure for decisions regarding the pricing of food products. In the article, we explained how to calculate the prices of food and catering companies using simple math. The application of any of the three mentioned techniques regarding existing circumstance will enable food production companies to ensure a straightforward yet accurate determination of the

product price that aligns with the current situation.

Keywords: Mathematical Expression; Price Determination; Food Companies

1. Introduction

The economic results of enterprises' commercial activities usually determine the financial level of countries and affect the possible standards of population living. Thus, to achieve the highest possible living standards, it is appropriate to promote improving every company's economic activity. So, how can a commercial activity unit be described? Business institutions' commercial activities as units are usually regulated by countries' laws. A company, as an economic entity, is clearly defined by law and conducts its business activities by legal regulations[1]. Any business entity is composed of materials (raw and finished products), tangible and financial assets, human resources, intellectual property, as well as its image, rights, and obligations. Each food production company has access to means for production making and raw materials and can perform production functions, and a certain collective of employees is united. Catering businesses implement the functions of coordinating the production making, sale, and consumption of meals and beverages. Organizing food consumption on-site is a unique feature of catering companies because other businesses rarely perform such a function. Food preparation for consumption is an ordinary activity that generates money for activity owners, business managers, and other employees in all states worldwide[2]. However, in some countries, there are still several types of non-profit catering institutions that are owned by other entities: canteens of kinder gardens or other preschool education institutions, part of the gymnasiums, and secondary schools canteens still belong to the education departments of municipalities, the canteens of healthcare institutions, state rehabilitation centers, shelter houses, and pensions belong to the healthcare departments of municipalities or the Ministry of Healthcare, as well as the canteens of military organizations owned by the Ministry of Countries National Defence. In many countries, catering companies are also the official objects of private business because private businesses are more responsible and achieve better results for consumers and owners[3]. In many countries, the question about ownership of catering companies is obvious and even non-negotiable from this point of view. The managers of every food production and catering firm are tasked with determining the appropriate price of meals, snacks, and beverages. Because proper and reasonable pricing is the basis for better commercial results, we consider the selection of appropriate pricing orders and rules for profit-making food production and catering enterprises to be an important contemporary issue for scientists and practitioners. The goal of this article is to provide quantitative (mathematical) expressions in the form of formulas that are appropriate for calculating the prices of food products, meals, and drinks under modern conditions and to make pricing as simple a process as possible. Indeed, a limited number of studies have examined the rationale behind pricing for food preparation establishments, and we have discovered that this area necessitates a comprehensive and systematic examination to uncover more contemporary solutions for pricing determination. In a previous study, some errors were found in the mathematical modeling[4], so we decided to refine some quantitative solutions[4]. We needed to synthesize the scientific studies of numerous researchers to identify the scientific prerequisites for pricing and the ways to create and describe possible quantitative (mathematical) expressions for finding decisions regarding the appropriate price of food products. In this article, we have presented mathematical expressions for three methods of determining prices for the production of food and catering companies. Each method's advantages and disadvantages are explained clearly and in detail, along with the conditions for their application. The article describes how to resolve food inventory and raw material (resources) quantity-controlling issues with food suppliers using the suggested techniques in the form of an artificial intelligence system[5].

2. Materials and Methods

Simplifying the pricing of food products is a common issue for domestic and foreign food companies, with foreign companies facing it more frequently. A clear, simplified explanation of price calculation methods would greatly facilitate those starting a food business and potentially help business professionals create their computer programs to help manage such companies. For example, many foreign companies from Eastern countries face the challenge of setting the right prices when they want to open catering businesses in Europe. In Vilnius, the capital of Lithuania, there are over 1200 establishments that sell Chinese food, and most of the owners of these businesses are foreigners. Applying simple mathematical formulas would greatly facilitate the activity for these owners as well.

The appropriateness of prices should be expressed by including a sufficient markup in the price of the food product to ensure the necessary profit[5, 6]. However, in practice, food production and catering enterprises employ diverse methods for calculating the price of their food products without any reasoned and logical justification. To obtain information from scientific and practical sources for the creation of quantitative expression (formulas), it was imperative to synthesize the scientific perspectives of a considerable number of scientists, thereby identifying the method, which we named as the *Main* method of calculating the food price. The division of food pricing methods according to mathematical expressions is an innovative and original scientific solution since more such studies are not presented, though their need is unquestionable.

So, the Main method is grounded in practice and widely employed in enterprises that do not yet employ quantitative accounting of raw materials[7–9]. A simple three-digit rule based on logic and determining proportionality was used to determine the quantitative (mathematical) expression:

For instance, if the price of a collection of raw materials (resources) is, T Euros and the markup let it being K%, then the total price A with calculated and added markup after some mathematical operations we made is equal[7, 8] to:

$$A = T (1 + \frac{K}{100}) \tag{1}$$

In this case, the markup is calculated for the entire meal or drink. And now it remains to calculate value-added tax. The quantum of value-added tax *VAT* as a percentage V_c is determined by the laws of every country, and it has to be calculated as follows:

$$VAT^2 = A \times \frac{V_c}{100} \tag{2}$$

After identifying the necessary steps, this formula could convey the mathematical expression of this method:

$$G_{-i} = T(1 + \frac{K}{100}) \times (1 + \frac{V_c}{100}) \tag{3}$$

Where: the ultimate selling price is G_i of *i-th* dish or drink;

K is the percentage form of the determined markup;

V_c—the value-added tax also is in percentage, which is determined according to the laws of every country.

As a rule, the percentage of value-added tax is determined as different sizes in most states of the world[10]. The cost of food raw resources collection T is calculated according to the quantities of ingredients indicated in the dishes' technological recipe. Managers (or chefs of the kitchen) in catering enterprises are capable of varying the quantities of raw materials (resources), and searching for the best option for the total taste of the dish until the technological recipe for each dish is approved by the head of the food company[10]. Sometimes even modifying the amount of spices or changing the proportions of raw materials can change the taste of the dish. Therefore, practical tests are needed until the taste of the dish is determined to be the best[10].

Mark-up K can be both fixed and flexible[9]. To simplify the controlling of accounting for the raw materials (resources), a fixed markup is usually usually calculated in only pioneer catering companies. The simplest accounting system, in other words, is the most favorable at the beginning of work in food production because every new owner usually has a lot of other issues to solve upon commencing a new venture. Accounting for raw materials only in monetary terms is common in such firms. A

fixed markup of the same size is equally calculated for all dishes, which we have previously called markup *K*. Calculating a fixed markup implies lower expenses and a simpler oversight of the accounting for raw materials [9]. Therefore, it is recommended that this approach be implemented in newly established food production and catering enterprises that lack the financial resources to procure computer software for accounting raw materials. That method is better understood by start-up owners, as the money flow is clearer within the company.

Likewise, the price of food production can also be computed in a ***Derivative*** way. We see it as a second way for price determination, i.e., when the markup varies, it may exhibit distinct variations for each product or product group. The variation of mark-ups is highly suitable for application in catering and other food production firms [11]. For example, the highest exceptional markup may be applied for materials that require more cost to obtain or allow the expression of the uniqueness of the catering company. The subsequent formula shall be employed to determine the cost of the dish after taking into account all the relevant conditions and circumstances, as well as the logical three-digit rule applied:

$$G_i = \sum_{i=1}^{n} B_n(1 + \frac{K_n}{100}) \times (1 + \frac{V_c}{100}) \qquad (4)$$

Where: B_n cost of the *n-th* quantity of raw food material (resource) in the dish,

K_n—mark-up added for *n-th* raw material (resource) in percentages;

G_i—final selling price of *i-th* dish or drink;

V_c—percentages of value-added tax is applied.

The size of the markup is usually decided by the managers, taking into account the situation in the marketplace for food production, interest in food items or dishes, and anticipated revenue. The markup size may be calculated differently for distinct food groups, such as vegetables, meat, dairy products, or alcoholic beverages. The markup may also be calculated as a different percentage for the individual product. A higher markup may even be required for some products [11, 12].

This method should be frequently applied because it is convenient to use a flexible markup (it means it is different for individual products) allows better commercial solutions, which always increases sales. After all, it is possible to vary prices, which can better satisfy consumers and thus achieve better commercial results. Deciding on a higher markup for individual foods (raw materials) usually leads to a higher final price of food products. However, calculating a higher price (in percentage form) is necessary for some products. For instance, the transportation of certain specific raw materials or ingredients from other remote lands sometimes require difficult, special storage conditions, usually incurring additional costs which are recovered at a higher markup. Additionally, using very specific raw food materials or ingredients such as exotic spices or some other food components usually enhances and broadens the flavor of food items or dishes or possibly improves appearance, which in turn can enhance the distinctiveness of a food company and increase its competitiveness.

The methods mentioned above for pricing allow the establishment of the price with the precision of even a small amount of cash (chips-cents). Restaurants or other open-type catering companies will find this inconvenient. Therefore, the third method, which we named Blind price selection [8], is the most suitable for such companies. This is currently the prevailing pricing technique in most countries. How can it be expressed in formulas? So, the essence of the method is explained below.

The first step is determining the cost of a collection of raw materials. It is necessary to take the same actions as in the first-mentioned method. The size of production cost, the willingness of consumers to purchase, their possibility to pay, their attitude towards some food, seasonality also, the economic circumstances, the political situation in the country, and other factors are further evaluated [13–16]. And then, according to the results, the managers of the food company have to choose the highest possible price of the food that would still be enough to satisfy consumer demand. The price of food production can be easily adjusted in this case. This method results in a Blind determination of the price, so it is crucial not to make a mistake. The above factors can determine the amount of the markup. The blind price selection technique is still regarded as the most adaptable method because of its flexibility, and it can be used to meet the needs of the market. This method allows managers to change the selling price of food even during the working

day if it is noticed that it is set too high or that the reaction of customers is inadequate to the determined food price. Setting a lower price is appropriate to invigorate the sale of such food products. Alternatively, it is possible to determine when the popularity of the meals is excessive enough, potentially exceeding the expense of its production, thereby justifying the increase in the price of the dish. Another possible issue for managers is calculating the added value tax sold of the company's prepared food and determining its cost-price. The method for calculating the markup appears intuitive and straightforward: from the blindly-determined sale price, it is necessary to subtract the price of a price raw materials collection and also the appropriate value-added tax. However, in that case, the value-added tax will be deducted, and its amount and method of calculation will differ from the added tax, which is calculated using the first and second methods[17, 18].

For example, by using the same simple and logical three-digit rule (we use information that in Lithuania Value added tax is 21%), the following logical proportions can be made:

in the sum of 121 EUR (100+21), the VALUE ADDED TAX is exactly 21 EUR (or %);

but in the 100 EUR, the VAT will be *VD* %.

In such a case, the value-added tax deduction shall be calculated as follows:

$$VD \quad = \quad \frac{V_c}{(100^2 + V_c)} \tag{5}$$

Where: *VD* is the value-added tax in a percentage form.

While calculating the amount of markup in food price by monetary terms, according to the necessary logical steps and based on a simple three-digit rule and mathematical calculations, we also derive the following formula:

$$V = C - C \times \frac{V_c}{(100^2 + V_c)} - T \tag{6}$$

Where: *C* is the blindly determined price of the food product in monetary terms;

T is the price of a raw materials collection in also monetary terms;

V_c—value-added tax as a percentage is fixed and different according to the laws of each country.

The prices fixed by this method are usually rounded to an integer. Rounding off the prices makes it easier for the visitors of food establishments to pay for food (especially with waiters and cashiers of catering firms) because there is no need to count small money and also makes it easier for food companies to settle with consumers of food companies. Raw materials are usually accounted for in quantitative terms using this method. Quantitative (fully computerized) accounting of food products is now used in almost all food industries, although some Eastern European countries and other developing countries do not have regulatory documents prohibiting the qualitative accounting of products.

3. Results

Further, we display the results of price determination in mathematical expression according to the Main method by calculating using the following Formulas: (1), (2), (3). For example, if the price of raw resources collected for food or drink production is 5 EUR, a markup is 300%, and the value-added tax determined in Lithuania is 21%, then the price of selling for such a food or drink would be 24.20 EUR. The results of the calculation using the Main method are presented in **Table 1**:

Table 1. Example of the price calculation using the Main method.

Name of Raw Resources	The Amount of Raw Material in the Food Product Following the Recipe, kg	Price of the Raw Material, EUR/kg	The Relative Price (Cost) of the Raw Materials in the Product or Dish, EUR
1.			
2.			
n			
Total (the cost of a set of raw materials):			5
Mark-up 300%, EUR			15
Total price of food product with markup			20
Value-added tax 21% (in Lithuania)			4.20
Total selling price, EUR			24.20

The order of the Derivative method used in **Table 2** form according to the Formula (4) should look like this (sample results):

The price calculation of food products according to the blind price selection method can only be completely computerized. Formulas (5) and (6) are required for computer program development to use the Blind Price Selection method.

Table 2. Example of the price calculation by the Derivative method.

Name of Raw Resources	The Amount of Raw Material in the Food Product Following the Recipe, kg	Price of the Raw Material, EUR/kg	The Relative Price (Cost) of the Raw Materials in the Product or Dish, EUR	Markup, in %	Markup, EUR	The Price Is Calculated with the Markup, EUR
1.	0.1	2	0.2	200	0.4	0.6
2.	0.1	2	0.2	200	0.4	0.6
n	0.2	4	0.8	400	3.2	4
	Total					5.2
	Value-added tax 21%					1.1
	Selling price, EUR					6.3

For example, suppose the sales price of a food product (dish) is set by the company managers at 20 EUR, and the cost of a set of raw materials in the monetary form is 7 EUR. According to Formula (6), calculation of the markup in monetary form will be as follows:

$$V^2 = 20 - 20 \times \frac{21}{100 + 21} - T = \\ 20 - 20 \times 21/121 - 7 = 9.5 \, EuR \tag{7}$$

Choosing the most appropriate method of determining the price of food products is a responsible decision of company managers.

4. Discussion

Each food production and catering company's managers are responsible for setting the prices for food items (dishes and beverages), and this process is especially relevant for profitable caterers[19, 20]. Non-profit companies do not interpret the price calculation because they sell dishes and drinks at cost. A collection of raw materials' calculated price is considered the total selling price of the food or beverage[18–20]. This practice is common in many countries around the world. The price of food products is affected by their quality[20, 21]. The food quality requirements are regulated in the states' normative documents. Therefore, using low-quality products reduces food prices, which in turn affects food safety. It can be said that price can also influence food safety[20–22]. This fact further confirms the relevance of the study and the necessity for its findings.

The food price is determined by the accounting of raw food materials (resources) in storage, which makes them suitable for computerized processes, but only if they combine accounting into a unified network with food suppliers. In that case, food suppliers can be able to control the possession of the necessary quantities of raw food resources, knowing the quantities of food in storage, and ensuring the elimination of the shortage of raw food resources[20–22]. Artificial intelligence could be applied to food companies' stock management. Food suppliers should know the range of prepared dishes and their possible demand and deliver the necessary raw materials for production making[23–25]. The proposed methods, presented in the form of structured information pricing possibilities, facilitate the determination of the appropriate price of food products. The mathematical differentiation of pricing methods is based on scientific reasoning and logical arguments[26]. Such a relationship between food suppliers and catering companies is based on the modern use of IT capabilities under the conclusions of scientific decisions in the form of artificial intelligence use aimed at facilitating the management of catering companies[26, 27]. Many authors consider choosing the right food pricing a problem[28, 29].

So, scientifically reasoned classification of food product price calculation methods is an original and innovative solution. It could help catering business man-

agers determine product prices more accurately and quickly. In addition, such a division of methods and their mathematical expression will allow these methods to be applied in any country worldwide, which will also obviously facilitate the work of food company managers.

5. Conclusions

Neither scientific nor special literature has clear, reasoned information about the pricing of food production. We found this gap in science and a relevant scientific issue for enterprises, the resolution of which would reduce the costs of accounting workers. Artificial intelligence can be applied in food inventory management because the quantitative (mathematically) expressed methodologies suggested in the article are easily applied in computerized programs.

The article proposed the Main, Derived, and Blind price determination and selection methods. It explained these methods and clarified their advantages and disadvantages depending on the company's situation. Each suggested method is mathematically expressed, and examples of their use are presented.

Understanding and effectively applying these methods will empower food production and catering companies to choose the most appropriate method to determine the price of food products under current circumstances and overcome various financial obstacles in pricing. The article also delineated the conditions and circumstances for the application of each of the proposed methods.

Author Contributions

Each credited author has contributed significantly to the article: RD created the methodology and developed the theoretical framework; MS analyzed the data and calculated the results; RD and MS contributed to the design and implementation of the research; RD. contributed to the analysis of the results and the writing of the manuscript. All authors discussed the results and contributed to the final manuscript.

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