IMPLEMENTATION OF METHODS AND MODELS FOR MANAGING PRICES AND RATES FOR SOCIAL SERVICES[1]

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Purpose: the paper is devoted to the use and implementation of complex tools for managing prices and tariffs for social services, based on the author's methods and models. *Discussion*: the methods and models proposed by the authors in the framework of previous studies require testing on real data. The division of the entire procedure of analysis and calculations into three interrelated stages is substantiated: pre-forecast analysis of prices (tariffs), calculation of a compromise price (tariff), search for the optimal pair «buyer – seller» («consumer – supplier»). Based on the results of approbation, a decision is made on the possibility of developing computer tools, the use of which will significantly optimize calculations at all stages. *Results*: the authors have tested and refined methods and models for managing prices (tariffs) for social services; the algorithm for the calculations required for further decision-making was approved: pre-forecast analysis (calculation of the Hirst index), calculation of the compromise price (tariff) for the service, selection of the optimal «consumer – supplier» pair (using the adapted TOPSIS method). The modeling of computer tools for managing prices (tariffs) for social services has been carried out.

Keywords: pricing, tariff setting, trade-off analysis, social services, analysis of alternatives, toolkit.

Introduction

The market of social services, which includes housing and communal services, transport (public transport) and medical (in public health institutions), does not obey the classical laws of economics; the demand for it cannot be regulated by the price (tariff), since most of the services are life-supporting, in connection with which buyers (consumers) are forced to purchase them for a set price (tariff). However, there is a so-called «social demand» [5, 12] in these

sectors, which can only be covered by subsidizing sellers (suppliers) or providing subsidies to consumers (at the moment, direct subsidies are not provided by law).

To set the price (tariff) for a social service and identify the volume of social demand, the methods and models previously proposed by the authors [1-5], which provide a set of necessary calculations to determine the compromise price (tariff) for social services, can be used. Further, they will be performed along with the calculations necessary to select the optimal pair «seller-buyer» («consumer-producer»). The cold water services will be analyzed as an example.

Research methodology

The first stage of the complex offered by the authors is the pre-forecast analysis of the price (tariff) values. Table 1 shows the values of the tariffs for cold water services from 2008 to 2021 in the context of six months (tariffs in Krasnodar, the main resource supplying organization).

In order to determine whether a time series of tariff values has such a property as persistence, which determines the possibility of its forecasting, the Hirst index will be used [7-11]. For the available values, the value of the normalized range R/S was calculated; the results are shown in Table 2. Due to their large volume, intermediate calculations are not presented.

Table 1

The size of the tariff for cold water services, 2008-2021

Year	First half-year, RUB / m^3	Second half-year, RUB / m^3
2008	10,9	10,9
2009	13,45	16,24
2010	17,06	17,06
2011	18,94	18,94
2012	20,05	21,14
2013	21,14	23,1
2014	23,1	23,93
2015	23,93	28,55
2016	28,55	32,27
2017	31,95	32,26
2018	30,73	32,26
2019	38,71	38,71
2020	38,71	38,71
2021	38,71	38,71

Table 2

Average R/S values for intervals n for the time series «Cold water services»

n	2	3	4
R/S	0,79269811	1,299969549	1,360700942

Based on the data obtained, a simple regression was performed using the least squares method. The slope of the linear regression equation is an estimate of the Hirst index. For the time series under consideration, the Hirst index equals 0,808, that makes it possible to conclude, that the analyzed time series is trend-stable. This means that the value of the tariff will continue to increase. It should be noted that all social spheres without exception are characterized by short time series of values of price (tariffs), which is due to the establishment of a new price (tariff) amount several times a year (sometimes less often). Thus, it is not possible to accurately predict the next price (tariff), however, information on the presence of time series persistence can be used for budget planning and etc.

Further, the calculation of the compromise tariff for cold water services will be made; for this, first of all, it is necessary to take into account all the manufacturer's costs for preparing this service for the consumer:

– water lifting;

– water purification;

– water transportation.

Thus, the cost of producing cold water can be calculated as follows:

$$c_C = c_R + c_P + c_T + c_D + c_I, \tag{1}$$

where c_C – cold water cost price; c_R – water lifting cost; c_P – water purification cost; c_T – water transportation cost; c_D – non-operating expenses; c_I – expenses from profit.

Taking into account the fact that the cold water service, like other communal utilities, cannot be provided in a certain established volume (the volume of consumption can only be actual), the calculation of the compromise volume can be neglected. If it is necessary to take into account the volume of consumed services, one should operate with data from previous periods or forecast data obtained also on the basis of data from previous periods.

The compromise price (rub / m3) for cold water services can be calculated as follows [5, 12]:

$$P_C^* = (c_R + c_P + c_T + c_D + c_I)\frac{1}{1-\sqrt{\frac{D'}{D}}} = c_C\frac{1}{1-\sqrt{\varphi}}. \tag{2}$$

Using (2), it is possible to obtain a compromise tariff for cold water services based on the total volume of services provided (the unit of measure for this service is 1 m³). If the cost of the service per 1 m³ is known, as well as the manufacturer's surcharge and the consumer's means of payment per 1 m³, the value can be calculated using D' – added value for 1 m³, and not on the total volume of services, and D – the maximum amount of the consumer's means of payment for 1 m³, and not for the entire volume of services provided.

Further an example of calculating a compromise tariff for cold water services will be performed. Due to the fact that the calculations are supposed to be made in each specific situation (using the information about the supplier's rate of return and the maximum amount that the consumer / consumer group has),

the compromise tariff obtained in each individual case may differ from others for the same service. For current calculations, we will set the supplier's rate of return to 2,2 RUB per 1 m^3, the maximum amount of consumer funds per 1 m^3 – 39 RUB; service cost – 29,5 RUB. According to formula (2), the compromise tariff for cold water supply services of 38,68 RUB for 1 m^3 was obtained. It should be noted that the planned tariff for the service in 2022 will be 38,93 RUB per 1 m^3 for all population groups; due to the fact that in the example under consideration, the maximum amount of the consumer's funds is 39 RUB per 1 m^3, the compromise tariff can be adjusted to the planned value, which will not lead to a violation of the social and market balance. In the case when an adjustment due to the amount of money available to the consumer is not possible, a tariff adjustment due to subsidies will be required. The total demand to be covered by subsidies will be social.

Next, it is necessary to select the optimal pair «consumer – supplier»; as it was noted earlier, the adapted TOPSIS method [1, 3, 5, 12] is used in this stage. Since the service considered as an example is communal, the following criteria were selected for the assessment: profit from activities (k_1); consumer debt for services (k_2); organization's debt to resource providers (k_3); amount of raised funds (k_4); average cost of performed works (provided services) (k_5); collection of funds for performed works (provided services) (k_6); receipt of claims for the quality of performed work (provided services) (k_7). These criteria should be divided into two groups and the coefficients of relative importance should be set (Table 3). It should be noted that the weighting coefficients are set for each specific calculation.

In accordance with the adapted TOPSIS method [5, 12], the experts then evaluate the alternatives according to the established criteria; three experts have been invited to carry out the procedure and three alternatives are being considered. After evaluating alternatives by experts, the following steps are sequentially performed [5]:

– calculation of the normalized decision matrix;

– calculation of a weighted normalized decision matrix;

– definition of «ideal positive» and «ideal negative» solutions;

– calculation of the separation metric;

– calculation of the relative proximity to the «ideal positive» solution;

– ranking of alternatives.

If necessary, the procedure for assessing alternatives can be supplemented with a procedure for assessing the competence of experts [1, 12].

Table 3

Supplier evaluation criteria

Criteria group	Coefficient of relative importance of criteria group	Critera	The coefficient of the relative importance of the criterion	Criterion weighting coefficient
1	2	3	4	5
K_1	0,55	profit from activities (k_1)	0,3	0,165
		amount of raised funds (k_4)	0,3	0,165
		average cost of performed works (provided services) (k_5)	0,2	0,11
		collection of funds for performed works (provided services) (k_6)	0,2	0,11
K_2	0,45	consumer debt for services (k_2)	0,25	0,1125
		organization's debt to resource providers (k_3)	0,4	0,18
		receipt of claims for the quality of performed work (provided services) (k_7)	0,35	0,1575

After completing all stages of the method, a cumulative assessment of each alternative will be obtained; the closer its value is to 1, the more a company is suitable for forming a «consumer – supplier» pair (Table 4).

Table 4

Alternatives' ranking results

Alternative	X*	X-	$\varphi_k(x_k)$	Rank
1	2	3	4	5
x_1	0,514	0,659	0,562	3
x_2	0,511	0,664	0,565	2
x_3	0,498	0,660	0,570	1

The discussion of the results

For the software implementation of the methods and models of compromise and multicriteria analysis in social spheres, it is necessary to develop a complex toolkit that makes it possible to simplify the work with the approaches and algorithms proposed by the authors, considering all their features for further software implementation [1, 2, 5, 12].

It has already been clarified that due to the fact that the author's methods are currently supposed to be used in three sectors (housing and communal services, passenger transportation (public transport) and medical services) it is advisable to divide the general structure of the final instrument into the corresponding three «modules» or provide the ability to fine-tune the system for one of the sector. For each of the options it should be able to implement the following functions:

– pre-forecast analysis of prices (tariffs) for the corresponding service (product) of a specific social sphere;

– calculation of a compromise price (tariff) for the corresponding service (product);

– selection of the optimal «buyer-seller» («consumer-supplier») pair using a multi-criteria analysis of alternative enterprises.

It should be noted that despite the differences in the functioning of social sectors, the tools for pre-forecast analysis, the calculation of compromise prices (tariffs) and the selection of the optimal pair will be similar.

For a clearer understanding of each of the designated functions it is necessary to simulate automated processes.

Fig. 1 illustrates the process «Conducting a pre-forecast analysis of prices (tariffs)». From the figure it is obvious that with an insufficient number of observations (time series values), the pre-forecast analysis cannot be carried out; with a permissible number of values, the pre-predictive analysis is performed using the Hirst normalized range method. The process provides for the possibility of supplementing the time series of prices (tariffs) for specific services provided by enterprises in social sectors.
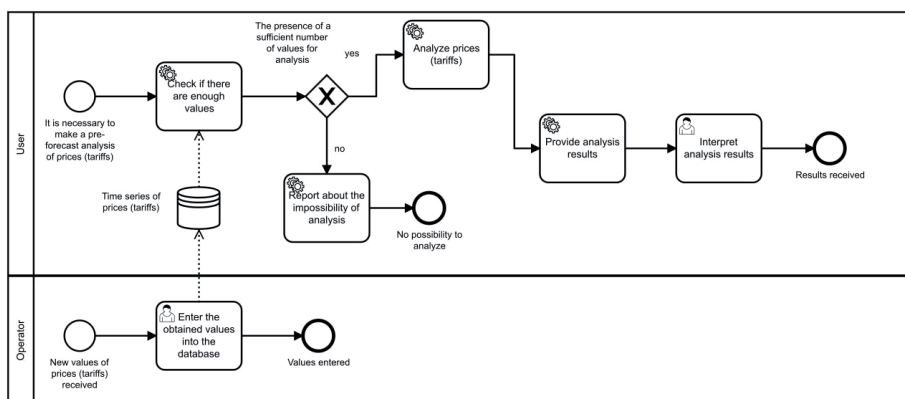

Fig. 1. BPMN-model of the process «Predictive analysis of prices (tariffs)»

The process of calculating the compromise price (tariff) for services provided by enterprises in social sectors is illustrated in Fig. 2. To calculate the compromise price (tariff) it is necessary to collect information about consumers (the maximum amount of money they can allocate to pay for the service; division of consumers into groups is acceptable), as well as about «sellers» (the amount of excess income). An important element of the calculations in the framework of this process is to determine the presence of social demand for a specific service and its size, as well as the calculation (if possible) of the amount of subsidies.
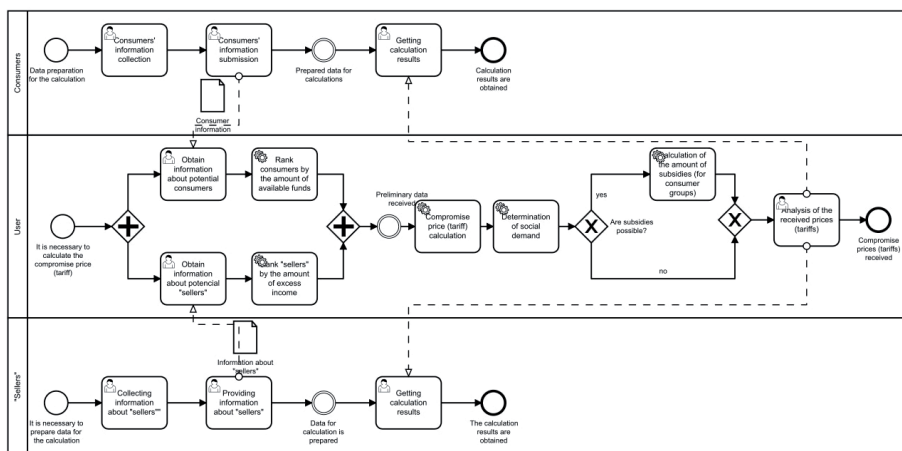
Fig. 2. BPMN-model of the process «Compromise price (tariff) calculation»

The most difficult and time-consuming process is the process of evaluating the alternatives for selecting the optimal «consumer-supplier» («buyer-seller») pair; within its framework, the TOPSIS method adapted by the authors is implemented. It requires the selection of criteria for evaluating alternatives, placing the coefficients of the importance of the criteria, directly conducting a multi-criteria assessment of alternatives, adjusting the estimates obtained taking into account the competence of the experts involved (optionally), ranking alternatives. The process is illustrated in Fig. 3.
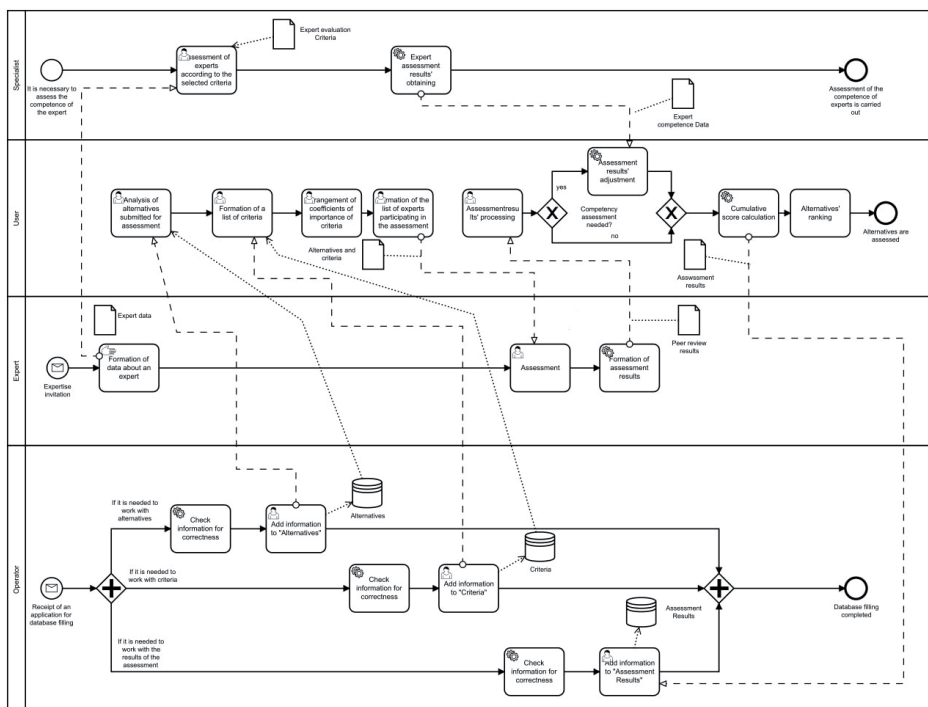

Fig. 3. BPMN-model of the process «Assessment of alternatives»

Conclusion

The methods and models proposed by the authors, which have become stages of the methodology for managing price and tariff setting in social spheres, take into account all the features and allow to form an optimal trajectory for both buyers (consumers) and sellers (suppliers). The main feature of the proposed toolkit and its advantage over previously used methods is the ability to take into account social demand and calculate its volume, as well as support for multi-criteria analysis of sellers (suppliers).

The implementation of the author's methodology on the basis of the developed models within the framework of computer toolkit will significantly increase the accuracy and speed of calculations.

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РЕАЛИЗАЦИЯ МЕТОДОВ И МОДЕЛЕЙ УПРАВЛЕНИЯ ЦЕНАМИ И ТАРИФАМИ НА СОЦИАЛЬНЫЕ УСЛУГИ

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Цель: статья посвящена вопросам использования и реализации комплексного инструментария управления ценами и тарифами на социальные услуги, базирующегося на авторских методах и моделях. *Обсуждение*: методы и модели, предложенные авторами в рамках предыдущих исследований, требуют апробации на реальных данных. Обосновано разбиение всей процедуры анализа и расчетов на три взаимосвязанных этапа: предпрогнозный анализ цен (тарифов), расчет компромиссной цены (тарифа), поиск оптимальной пары «покупатель – продавец» («потребитель – поставщик»). По результатам апробации принимается решение о возможности разработки компьютерного инструментария, использование которого позволит существенно оптимизировать расчеты на всех этапах. *Результаты*: авторами апробированы и уточнены методы и модели управления ценами (тарифами) на социальные услуги; утвержден алгоритм проведения расчетов, необходимых в дальнейшем для принятия решений: предпрогнозный анализ (вычисление показателя Херста), расчет компромиссной цены (тарифа) на услугу, подбор оптимальной пары «потребитель – поставщик» (с использованием адаптированного метода TOPSIS). Произведено моделирование компьютерного инструментария управления ценами (тарифами) на социальные услуги.

Ключевые слова: ценообразование, тарифообразование, компромиссный анализ, социальные услуги, анализ альтернатив, инструментарий.

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