The Regression Model of the Pay Back Period of Expenditures for a Cafeteria Opening

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Abstract: The sphere of services is actively developing in the modern world the level of which affects the quality of life of the population and the attractiveness of the place among the tourists. Catering companies make up an important part of the service sector. The aim of the study: a regression model development for calculating the cost recovery for opening a cafeteria in Kazan (Russia). Research methods: one-parameter and multi-factor regression analysis, calculation of the discounted payback period, internal rate of return, net present cost of the project. The results of the study: the equation of regression dependence of the discounted payback period (Y) on the value of the average sales price in the cafeteria menu (X1), construction and installation costs and equipment purchase (X2), discount rates (X3) is obtained. The multiple correlation coefficient of 0,954 indicates high accuracy of calculation. The suggested model will allow to make the payback period estimation for any public catering enterprise on the base of selected initial factors. The results obtained can be useful for investors and developers.

1 INTRODUCTION

The population quality of life directly depends on the level of the service sector development , with the catering as an important constituent part. Historical analysis carried out by Nadyrova D.A., shows that places for public catering were already in the middle of the XIX century as part of multifunctional leisure complexes built. They included also trading areas and areas for cultural and entertainment leisure (Nadyrova, 2017).

A present world pays attention to the formation of unnecessary food waste in public catering . Ch. Malefors, I.Strid and M. Eriksson write that the global goal of public catering is to halve food waste by 2030 (Malefors, Strid, Eriksson, 2022). N. Sundin, Ch. Malefors , M. Danielsson, M. Hardiyanti, Ch. Persson Osowski and M. Eriksson draw attention to the fact that 260 million state-funded school lunches, which are served annually in Sweden, form 21,000 tons of food waste (Sundin, Malefors, Danielsson, Hardiyanti, Persson Osowski, Eriksson, 2023). P. Kaur, Sh.Talwar, A. Madanaguli, Sh. Srivastava and A. Dhir write of corporate social responsibility rising in the hospitality industry (Kaur, Talwar, Madanaguli, Srivastava, Dhir, 2022). V. Filimonau, Ch.-Ch. Chiang, L.-en Wang, B. J. Muhialdin and V. A. Ermolaev consider the need to reduce food waste in gourmet restaurants with the participation of cooks (Filimonau, Chiang, Wang, Muhialdin, Ermolaev, 2023). C. Malefors, I. Strid, Per-A. Hansson and M. Eriksson have created forecasting models of the number of necessary meals on purpose of food waste minimization at public catering facilities based on traditional methods and using neural networks (Malefors, Strid, Hansson, Eriksson, 2021). The creation of a system for tracking plate waste and forecasting the number of guests as well as the use of tasting spoons and information campaigns are found to be effective tools for reducing plate waste in school canteens in Sweden (Malefors, Sundin, Tromp, 2022). In addition to excessive portions, food waste occurs in the catering industry when food is spoiled. C. Willis, Mclauchlin,

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C. Amar, L. Sadler-Reeves, N. Elviss, H. Aird, A. Fox and M. Kaye conducted a study of pre-sliced fruits in catering and retail establishments in the United Kingdom in order to assess their microbiological safety (Willis, Mclauchlin, Amar, Sadler-Reeves, Elviss, Aird, Fox, 2016). The crisis caused by the COVID-19 pandemic has affected the restaurant business, while new delivery and takeaway services become helpful to achieve financial stability (Neise, Verfürth, Franz, 2021). According to Julia C. Carrillo Ocampo, Matilda Marshall, Lotte Wellton and Inger M. Jonsson, one of the ways to achieve sustainable development of restaurants in the post-crisis period is to buy local products with a minimum delivery distance (Carrillo Ocampo, Marshall, Wellton, Jonsson, 2021). N. Messabia, , Paul-R. Fame and C. Kooli in their study analyze the experience of owners of small and medium-sized enterprises in the catering sector during the COVID-19 crisis. Several problems were identified: employee shortages, financial losses, the problems of liquidity and difficulties in adapting to changes (Messabia, Fomi, Kooli, 2022). Strategic response in the field of pricing, maintaining customer loyalty in restaurants in Turkey become the object of research in the works of F. Semercioöz, Ç. Pehlivan, A. Sözüer A. Meruntat and G. Altş (Semercioöz, Pehlivan, Sözüer, Mert, 2015; Altuntaş, Semercioöz, Mert, Pehlivan, 2014).

The national cuisine of the regions are important in connection with the development of tourism in the context of the search for the uniqueness of the proposed tourist product (Mengual-Recuerda, Tur-Viñes, Juárez-Varón, Alarcón-Valero, 2021). Catering enterprises are an important part of tourism centers (Pokka, Gafiyatullina 2020). For successful further tourism development a well-developed infrastructure is needed, including a variety of catering enterprises from a canteen to a restaurant not only in communities but also within the clusters of roadside services (Khusnudinova, Zabruskova, 2018). The economic aspects of the public catering enterprises functioning concern the organization of electronic accounting, the selection of optimal packaging (Sularto, Wardoyo, 2015; Ronzonia, Accorsia, Guidania, Manzinia,. 2022). The work of D. Eravia, Tri Handayani and Julia examines the effectiveness of business in the food and restaurant industries. It is negatively affected by: limited access to capital and raw materials, information technologies restriction , lack of qualified human resources and a high bank interest rate (Eravia, Tri Handayani, 2015). The relationship between various indicators of catering enterprises activities was also reflected in the works of foreign authors. A. Qa show and Ya. Saleh performed a regression analysis based on sixteen factors and revealed the degree of their influence on the effectiveness of marketing in small and medium-sized restaurants in Palestine (Qashou, Saleh, 2018). Based on the analysis of variance M. A. A. Majid, M. A. M. Alias, A. Samsudin and Ch. T. Chik calculated the strength of the brand in three different family restaurants and were able to identify the best of them (Majid, Alias, Samsudin, Chik, 2016). Y. Sha, X. Song, J. Zhan, L. Lu, Q. Zhang and Y. Lu found in their study that large restaurants are at higher risk of food safety than small restaurants which was confirmed by negative binomial regression (Sha, Song, Zhan, Lu, Zhang, Lu, 2020). The study of public catering enterprises is of importance according to the analysis of key literature references . Mathematical models allow one to perform analysis and prediction and make recommendations based on analitic data set. The results gained from the simulation are distinguished by their accuracy and measurability. The purpose of this study is to perform economic calculations to create a regression model of the payback period for a catering company using the example of a cafeteria in Kazan (Russia).

2 METHODS

The following calculation methods were used:

– the method of graphic construction;

–the net present value of the project evaluating:

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+d)^t} - \sum_{t=1}^{T} \frac{I_t}{(1+d)^t} - I_0,$$

where d – is a discounting rate;

Ct – serving dish proceeds in the studied catering company in the period t;

I_t – current expenses in the period t;

I_0 – initial investment in the project;

– the calculation method of the discounted payback period (PbP);

– the calculation method of the internal rate of return (IRR);

– the calculation method of the investment index return (PI)

– one-parameter modeling method: impact analysis of the selected factor influence on the result indicator at the same values of other selected factors;

– regression analysis: identification of the relationship between the outcome and the selected group of factors;

– a linear normalization method for moving from different units of measure to normalized (comparable) results:

$X_{in} = \frac{X_{ik} - X_{min}}{X_{max} - X_{min}}$,

where

X_{in} – normalized value;

X_{ik} – sample variable value;

X_{min} – minimum value from sample;

X_{max} – maximum value from sample.

3 RESULTS AND DISCUSSION

Recently, the administration of Kazan city has been paying great attention to the organization of recreation areas, landscaping and restoration of the city's attractions and, in general, to the convenience of the population in different parts of the city.

Public catering improves people's lives, absolve from low-productivity work, allows more time for active recreation. Let's consider the construction of a cafeteria in «Square of the 100th anniversary of the formation of the construction industry in the Republic of Tatarstan » in Kazan. There are fountains on the territory of the square operating during the summer period. Large remote control cars are also rent out by entrepreneurs and are in demand among children. The entire area of the fountain is filled with ice in winter. A large district Christmas tree is erected there and there is a skate rental shop nearby. It is necessary to locate the cafeteria pavilion in close proximity to them.

Calculations have shown that the cafeteria will be able to serve about 10-159 visitors per day with an average bill of 700 - 1000 rubles.

Costs and final performance indicators for an estimated period of 5 years are presented in Table 1

Table 1: Basic indicators.

Order number	Name	Numerical value	Measurement unit
1.	Construction and installation work costs and the purchase of equipment	3 078 000	rub.
2.	Pavilion purchase	4 398 000	rub.
3.	Preparation costs	671 000	rub.
4.	Costs for utility charges, salary payment , social security contributions, advertising and land rental per month	846 728	rub.
5.	Raw materials costs per month	673 364	rub.
6.	Net present value of the project (NPV)	2 105 013	rub.
7.	Simple payback period	3.42	yrs
8.	Discounted payback period (PbP)	4.52	yrs
9.	Discount rate	30	%
10.	Internal rate of return (IRR)	38	%
11.	The investment index return (PI)	1.17	разы

(Source: calculated by the authors)

Let us take a look at the payback period of the project (Y) will change with an increase in the sales price (X1), the costs of construction and installation work and the purchase of equipment (X2), and the discount rate (X3). Such single-parameter modeling shows a change in the payback period only with an increase in one factor and constant values of others (Table 2).

Table 2: Changing the payback period with an increase in selected initial factors.

Order num-ber	Factor growth in percentage	Change in discounted payback period (U) with:		
		an increase in selling price (X1)	an increase in costs for construction and installation work and the purchase of equipment (X2)	an increase in the discount rate (X3)
1.	100%	4.52	4.52	4.52
2.	110%	3.88	4.57	4.68

3.	120%	3.45	4.63	4.87
4.	130%	3.15	4.68	5.07
5.	140%	2.93	4.74	5.30
6.	150%	2.76	4.79	5.56
7.	160%	2.63	4.85	5.87
8.	170%	2.52	4.90	6.23
9.	180%	2.43	4.95	6.67
10	190%	2.35	5.01	7.23

(Source: calculated by the authors)

Each of the selected factors affects the value of the discounted payback period: an increase in the selling price leads to its decrease, an increase in the other two indicators leads to an increase (Fig. 1).

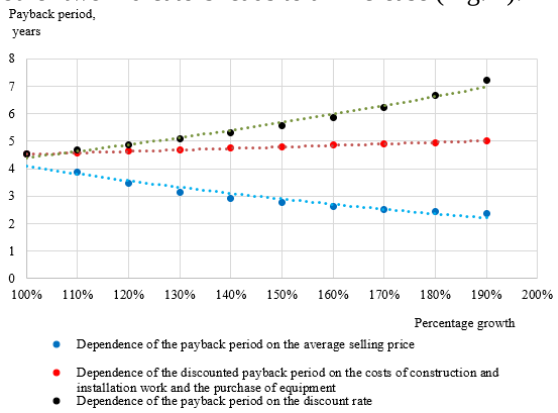

Figure 1: Change in discounted payback period in one-parameter modeling. (Source: proposed by the authors)

The dependence of the discounted payback period on the selected factors can be expressed by equations, the significance of which is confirmed by the high values of the approximation reliability indicators - R2 (Table 3).

Table 3: Univariate linear regression.

Model	Name	Equation	R2
Univariate linear regression	Plot of Y against X1	$y = 8.1126e^{-0.687x}$	0.933
	Plot of Y against X2	$y = 4.0341e^{0.1143x}$	0.999
	Plot of Y against X3	$y = 2.641e^{0.5107x}$	0.983

(Source: calculated by the authors)

Let us consider how the value of PbP (Y) will change with a simultaneous change in all initial factors: the price of selling (X1), the construction and installation work costs and the purchase of equipment (X2), the discount rate (X3). The minimum sample size was determined based on the number of initial factors (X1, X2, X3) and free terms of the equation (1 piece) - 20 options (Nizamova, Borovskikh, Shagiakhmetova, 2022). To increase the accuracy of calculations, 32 options for the development of the situation were analyzed (Table 4).

Table 4: Basic data for calculating regression dependen

Percentage growth

Order num-ber	X1, average selling price, rub.	X2 the construction and installation work costs and the purchase of equipment, rub.	X3, the discount rate, %	Y, payback period, yrs
1	239	3 078 000	30	4.52
2	239	3 385 800	33	4.79
3	239	3 693 600	20	4.33
4	239	4 001 400	10	4.14
5	239	2 770 200	12	3.78
6	239	2 462 400	15	3.86
7	239	2 616 300	25	4.32

8	239	2 154 600	18	3.90
9	271	2 154 600	20	3.46
10	306	2 462 400	15	3.07
11	324	2 770 200	16	3.00
12	343	3 385 800	23	3.05
13	208	3 359 700	17	4.76
14	223	3 693 600	14	4.22
15	271	3 785 940	25	3.80
16	423	4 309 200	28	2.82
17	271	3 078 000	28	3.83
18	306	3 078 000	20	3.25
19	343	3 078 000	25	3.09
20	324	3 078 000	28	3.26
21	208	3 078 000	13	4.51
22	208	3 078 000	10	4.40
23	179	3 078 000	2	4.95
24	193	3 078 000	11	4.87
25	271	3 385 800	30	3.95
26	288	3 539 700	30	3.73
27	288	3 693 600	30	3.76
28	271	3 847 500	30	4.07
29	288	3 938 450	30	3.79
30	362	4 281 200	30	3.16
31	382	4 281 200	30	3.07
32	423	3567700	30	2.82

(Source: calculated by the authors)

The selected factors (X1, X2, X3) have different units of measurement so they need to be normalized. To accomplish this the linear normalization method was used (Borovskikh, Shagiakhmetova, Nizamova, Kazymova, 2021).

The resulting multiple regression equation shows the dependence of the discounted payback period (Y) of the project on all factors simultaneously (X1, X2, X3):

$$Y= 0.726-1.283X_1+0,265X_2+0.195X_3,$$

где Y- discounted payback period of the project (PbP), years,

X_1 – selling price, rub.,

X_2 – the construction and installation work costs and the purchase of equipment, rub.

X_3– the discount rate, %.

The equation is characterized by the following results of regression statistics (Table 4).

Table 4:Regression statistics.

Order number	Name	Values
1.	Multiple R	0.954
2.	R-square	0.910
3.	Normalized R-square	0.900
4.	Standard error	0.094

5.	Observations	32

The multiple correlation coefficient shows the accuracy of the model and the relationship between the selected factors and the final indicator. The value of 0.954 indicates high accuracy of calculations. An R-square of 0.910 shows that 91% of changes in the discounted payback period are due to the selected factors and only 9% are due to factors not selected for modeling. The resulting model shows that the payback period of a public catering enterprise depends to a greater extent on the selling price and to a lesser extent on the construction and installation work costs and the purchase of equipment, the discount rate.

4 CONCLUSIONS

The calculations made by the authors allow to obtain the relationship between the discounted payback period (PbP) and the selling price, the construction and installation work costs and the purchase of equipment, and the discount rate. As an example the authors proposed the construction and operating of a public catering enterprise for 5 years.

The regression dependence was calculated on the basis of 32 observations. The R2 of the multiple regression equation is 0.91, which indicates that the calculations were performed correctly. The model proposed in the work will make it possible to predict the payback period for any public catering enterprise based on selected initial factors.

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