MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

State Higher Educational Institution "Kyiv National Economic University named after Vadym Hetman»

Institute of Information Technologies in Economics

Coursework

in the subject “Systems Analysis”

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CONTENT

INTRODUCTION

Systems analysis allows us to investigate complex objects and phenomena through identifying their structure, elements and relationships. In this study The object of analysis is an old bakery - as an example of a holistic system, which includes people, resources, processes and the external environment.

The idea to address this topic arose from a personal interest in traditional baking culture and a desire to understand more deeply how they worked similar institutions. In addition, such a system has its own unique atmosphere, which deserves to be preserved and understood from the point of view of modern approaches to labor organization.

The aim of the study is to model the interaction of key elements of an old bakery and identifying ways to adapt this system to modern conditions. Considering the bakery as a system allows us to identify shortcomings in its structure or processes, as well as suggest ways to optimize them. Application modeling allows you to reproduce the operation of the system without the need to intervene in real process, which is especially important when studying historical examples.

1. MODEL DESCRIPTION

1.1. Basic modeling processes

A model is a simplified representation of a complex real system that allows to explore its individual aspects without resorting to full implementation. In the case of our research is a bakery that operates on the basis of ancient recipes that reflect the cultural and gastronomic traditions of the past.

When building a bakery model, the following main properties are taken into account: analogicality, formalization, informativeness, purpose, scale, abstraction.

Analogy — the bakery model resembles a real system: it includes real participants in the process (bakers, customers, suppliers), describes the interaction between them, the stages of making desserts and serving customers.

Formality - processes within the bakery are described in the form diagrams, data structures and information flows, which allows for clear determine the functionality of the system.

Informativeness - the model allows you to get an idea of the key bakery processes, including recipe management, ingredient accounting, interaction with customers.

Purpose — the model is designed for the purpose of analysis and improvement internal bakery processes, as well as preserving and maintaining authenticity ancient recipes.

Scalability — the model can be expanded by adding new components, such as delivery, online orders or interactive menu with historical facts.

Abstraction - the model does not take into account every little thing, such as emotions customers or the appearance of the hall, but allows you to focus on the key functional and informational connections.

1.2. Modeling process

Process modeling is an important component of systems analysis, because it allows you to determine how the system's internal processes work and how they interact with other components. As part of the study of ancient bakery, a simulation model was chosen because it allows for the simulation of complex production processes under conditions of uncertainty, without interfering with real system.

For a deeper understanding of the functioning of the bakery, I will design different types diagrams according to the selected model. The black box diagram allows consider the bakery as a single system with input and output flows, focusing on external influences without detailing internal structures. A context diagram is used to visualize the interaction bakeries with the external environment, in particular with suppliers, customers and regulatory authorities. Zero-level data flow diagram (DFD) details internal processes, e.g. bread making, management ingredient stocks or order processing.

2. ANALYSIS OF THE ANCIENT BAKERY MODEL

2.1. System description of the object

Description of input data:

Raw materials and ingredients

· Flour, yeast, sugar, spices, eggs, dairy products

Coffee beans, tea leaves, honey, cocoa

· Dessert decor, packaging materials

Equipment and resources

· Oven, mixer, coffee machine, refrigeration equipment,

· Electricity, water, consumables (napkins, packaging)

Information

· Ancient recipes (used only by the chef)

· Menu, e-orders, customer reviews

· Schedule of events (lectures, seminars), staff work schedule

Human resources

· Pastry chef, bakers, waiters, administrator, courier

Interaction with the environment

· Ingredient suppliers

Regulatory requirements (sanitary, tax)

· Customer flow (tourists, locals)

Output data:

Finished products

· Fresh baked goods (in the morning)

Desserts (after lunch and in the evening)

· Drinks (coffee, tea)

· Gift sets

Services

· On-site service, takeaway and delivery

· Lectures and seminars on desserts, history, styles

· Holding events or workshops

Information outputs

· Electronic checks, order database, financial reports

· Website page with updated menu

· Visual and cultural experiences of customers

· Preservation/transmission of traditions through experience

For a better understanding, I present the "black box" model.

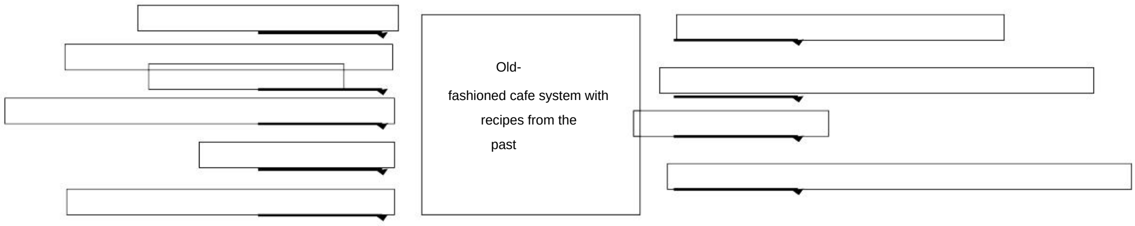


Diagram 2.1 Black box model

The structure of the precariat consists of the following subsystems:

1. Store Owner - Strategic Management
2. Director - general administrative management
3. Executive Director - daily operational coordination
4. Accountant - financial accounting and reporting
5. Managers — HR, sales, supply management
6. Sales consultants - customer service, advice on goods
7. Cashiers — conducting financial transactions
8. Warehouse Manager - Logistics and Goods Accounting
9. Grushchyki — loading/unloading of goods
10. Cleaners - cleanliness and sanitation
11. Suppliers - supply of goods
12. Lecturers - conducting educational lectures and seminars
13. Analytics - collection, processing and analysis of data for decision-making
14. IT specialists — technical infrastructure support
15. Human Resources - recruiting, personnel registration, HR processes

16.Waiters - serving customers in food areas

17. Chef - manages the kitchen, develops the menu

18. Sous Chef - helps the chef, controls the processes in the kitchen

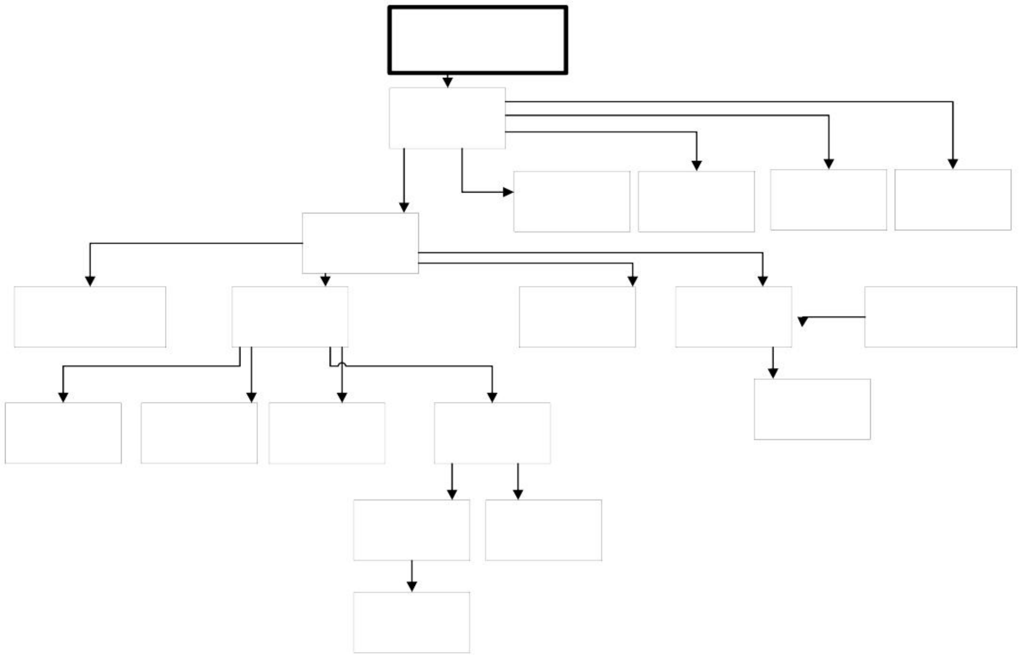


Diagram 2.2 System topology

Interaction of the studied system with the external environment

– Governing bodies, partners, learning platforms ÿ Provision standards, plans, licenses, schedules, training materials, price lists.

– Financial institutions, tax services ÿ Reporting, statistics, submitting applications, receiving or transferring funds.

– Suppliers ÿ Delivery of raw materials, products, goods according to schedule.

– Buyers and visitors ÿ Payment for goods and services, receipt consultations and service.

– Other organizations (competitors, market, trends) ÿ Influence through competition, changing demand, technological innovation.

– Recruitment agencies, training centers ÿ Personnel search, promotion employee qualifications, internships.

2.2. Building data flow diagrams

A context diagram allows you to identify key processes and interactions that necessary for the efficient functioning of the old bakery, and serves a base model for further detailing through lower-level diagrams.

It depicts the system as a whole and shows its main external sources.

impact — users, suppliers, equipment, as well as information and

material flows that enter or leave the system.

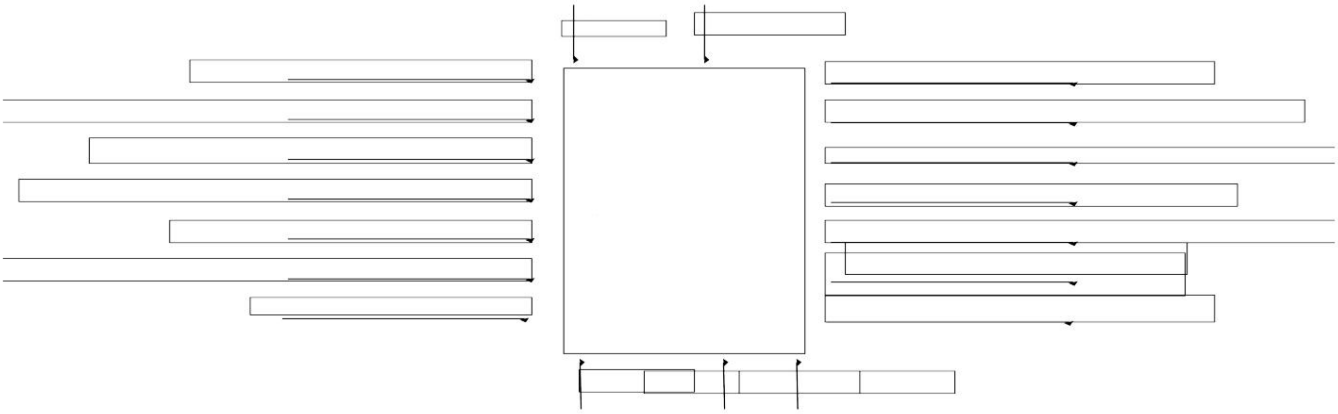


Diagram 2.1 Bakery Context Diagram

Unlike a context diagram, where the entire system is presented as a single process, a zero-level data flow diagram (DFD) breaks the system down into key sub-processes and interactions with the environment, shows how the bakery accepts orders from customers, works with suppliers, organizes events, advertises its products, and carries out financial reporting and engages staff.

The diagram assumes the presence of data stores that store information, important for the functioning of the bakery. These storage facilities ensure the preservation of and access to data received or generated during interaction with external environment, and is an important part of any flow model data

Such repositories include:

· Customer order database for recording orders, flavors preferences and contacts;

· Warehouse records to track ingredient deliveries and leftovers;

· Financial documentation for storing reports, invoices and checks;

· Recipe archive for storing traditional recipes, technological maps and cooking methods;

- Event and booking schedule for planning workshops, celebrations events, etc.

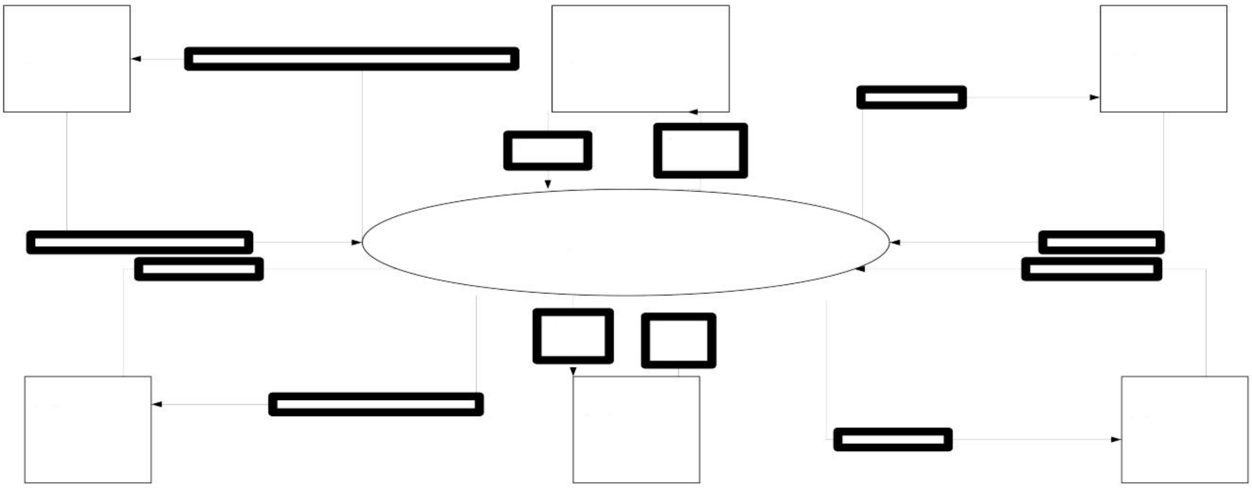


Figure 2.2 Level 0 Data Flow Diagram (DFD)

3. CONSTRUCTION OF AN OPTIMIZATION MODEL BASED ON A LINEAR REGRESSIONS

3.1. Calculation using formulas in Excel

I will use MS Excel to build a revenue forecast for the bakery.

For the forecast model, I will write down the data for the year 22, where X is the number of units sold. of products, Y is the price per piece. For X, the forecast is 20 sold units.

We have the following table:

Table 3.1 Values of X and Y

No.	Y(i)	X(i)
1.00	0.70	1.00
2.00	0.80	4.00
3.00	0.90	6.00
4.00	1.00	8.00
5.00	1.40	10.00
6.00	2.00	12.00
7.00	2.80	14.00
8.00	3.50	16.00
9.00	4.60	17.00
10.00	9.50	18.00
11.00	8.00	19.00
pr		20.00

All calculations were performed in this table:

Table 3.2 Reasons for using linear regression

No. Y(i)		X(i) X2(i) 1/X(i) ln(X) ln(Y) Yp(exp) Yp(parab)						
1.00	2.00	1.00	1.00	1.00	0.00	0.69	0.42	2.28
2.00	0.80 4.00 16.00 0.25				1.39 -0.22		0.50	0.93
3.00	0.90	6.00 36.00 0.17			1.79 -0.11		0.52	0.54
4.00	1.00	8.00 64.00 0.13 2.08 0.00					0.54	0.58
5.00	1.40 10.00 100.00 0.10 2.30 0.34						0.55	1.03

6.00	2.00	12.00	144.00	0.08	2.48	0.69		0.57	1.90
7.00	2.80	14.00	196.00	0.07	2.64		1.03	0.58	3.19
8.00	3.50	16.00	256.00	0.06	2.77		1.25	0.59	4.89
9.00	4.60	17.00	289.00	0.06	2.83		1.53	0.59	5.90
10.00	9.50	18.00	324.00	0.06	2.89	2.25		0.59	7.02
11.00	8.00	19.00	361.00	0.05	2.94	2.08		0.60	8.23
pr		20.00	400.00		3.00			0.60	9.56
ave/sum	3.32		162.45		2.19	0.87			3.32

Y(i) is the value of the dependent variable for each observation.

X(i) is the value of the independent variable for each observation.

X^2(i) is the square of the value of X for each observation for a parabolic models.

ln(Y) — natural logarithm of Y, for analyzing logarithmic dependencies.

Yp(exp) are the predicted values of Y obtained through the exponential model (Y = a * e^(bX)).

Yp(parab) are the predicted values of Y obtained through parabolic model ($Y = a * X^2 + b * X + c$).

In this graph, you can see that the points are not linearly arranged, so The dataset was examined for other types of addiction.

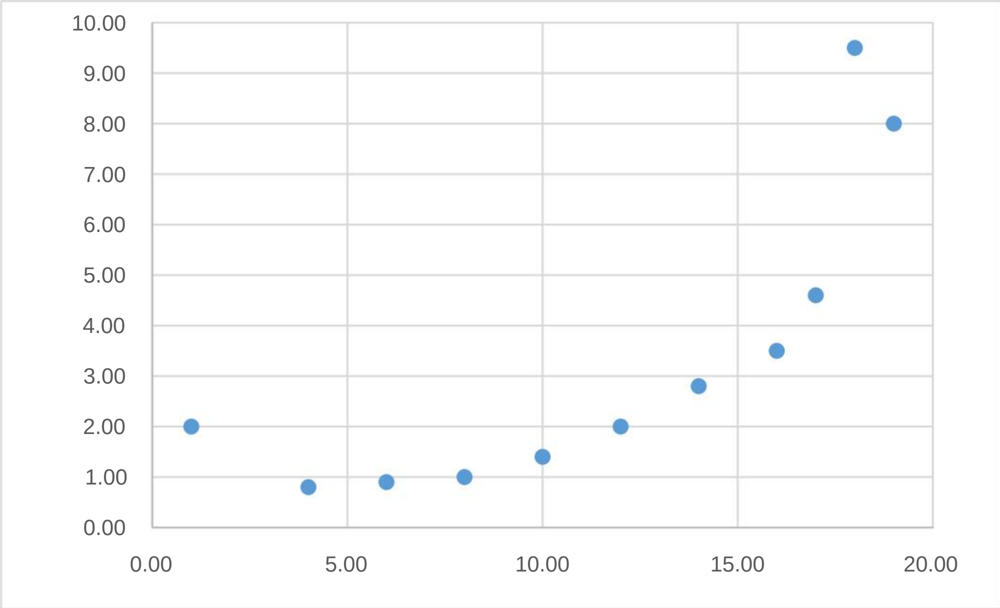


Figure 3.1 Location of problem data

A comparative table with the results of the survey is presented for your attention. regression analysis.

Table 3.3 Model comparison table

Model No.		R^2	E	F
1	Linear	0.600562	1.9627	13.53168
2	Parabolic	0.878327	1.148956	28.87494
3	Hyperbolic	0.079534	2.979432	0.777651
4	Logarithmic 0.30		2.606027	3.78
5	Stepeneva	0.321323	0.738041	4.261096
6	Exponential	0.696748	0.493345	20.67828

Next, we will analyze the parabolic model as it showed the best results.

Table 3.4 Results of calculating values using LINEAR

0.052201	0.713524174	2.946	#N/A
0.012215	0.262168042	1.193	#N/A
0.878327	1.148955762	#N/A	#N/A
28.87494	8	#N/A	#N/A
76.23557	10.56079474	#N/A	#N/A

= 2.946088115ÿ0.71352 + 0.052201 2

a (X^2)=0.052201: the price increases with high sales volume. This means that that after a certain point, increased sales lead to an increase in price — perhaps due to shortage or premium product.

b (X) =-0.713524174: at small sales volumes the price decreases — perhaps this is due to basic discounts at the start or a promotional price.

c (free term)=2.946: initial price with zero sales (pure theoretical value that sets the initial level).

R^2=0.87: 87% of the price variation is explained by the chosen model. This indicates about a high level of compliance.

E=1.14 on average the model deviates from the real values by 1.14 c.u., which is a relatively high value, especially in conditions of stable pricing.

F-test F=28.8: confirms the statistical significance of the model. Tabular The value of this criterion is 4.066. Exceeding this value gives us information that the model is significant.

SSY (total variance of Y)=76.23557: the value of the total variance of the variable Y. Indicates variability in prices.

SSreg (regression variance)=10.56079474: the portion of variance explained by model. If this value is large relative to SSY, the model is good.

The parameters t0, t1, t2, t tab were also calculated using the following tables

Table 3.5 Data calculations for parameters

No. e		ei2	S^2	$(x2 - x2\sim)^2$	x^4
1.00	-0.28	0.08		26067.57	1.00
2.00	-0.13	0.02		21448.93	256.00
3.00	0.36	0.13		15990.75	1296.00
4.00	0.42	0.18		9693.30	4096.00
5.00	0.37	0.14		3900.57	10000.00
6.00	0.10	0.01		340.57	20736.00

7.00	-0.39 0.15			1125.30	38416.00
8.00	-1.39 1.94			8750.75	65536.00
9.00	-1.30 1.70			16013.75	83521.00
10.00 2.48		6.17		26096.93	104976.00
11.00 -0.23 0.05				39420.30	130321.00
total 0.00		10.56 1.32		168848.73	459155.00

$S_{a1} = \sqrt{\frac{1}{\sum_{i=1}^{n}(X_i - X_c)^2}}$ and $S_{a0} = \sqrt{\frac{1}{n} + \frac{X_c^2}{\sum_{i=1}^{n}(X_i - X_c)^2}}$ for calculation $t_i = \frac{a_i}{Sa_i}$

The following values were obtained:

ttab = 2.306004135 (=STUDRASAPOBR(0.05;8))

sa1 = 0.747445014

ta1 = 0.004894594

sa0 = 1.50329713

ta0 = 0.509326137

ta2 = 0.208333592

sa2 = 0.095227627

None of the coefficients are statistically significant at the ÿ=0.05 level. Model although it has a good R^2, the coefficients cannot be interpreted with high This conclusion was reached due to the small amount of data

Based on the constructed regression model, a calculation was made the predicted value of the growth of the resulting variable for a given period.

Expected increase in the performance indicator: ÿ = 2.752847119

Lower bound of the forecast confidence interval: Y min = 6.803239328

Upper limit of the prediction confidence interval: Y max = 12.30893357

In order to determine the sensitivity of the performance indicator to change factorial feature, the elasticity coefficient was calculated, which shows that how many percent will the result value change when the factor variable changes by 1% and as a result of the calculations the elasticity coefficient is: K = 34.9334, which means that with an increase in the volume of products sold by 1%, the price per unit of goods decreases by 34.93% on average. Such a significant a negative coefficient indicates an elastic type of demand, where an increase in sales volumes are accompanied by a significant price reduction.

As a result, the following conclusions can be drawn:

1. Since Fproz = 28.8 > Ftabl = 4.066, then the quadratic equation is constructed the model Y = 2.9461 ÿ 0.7135·X + 0.0522·X^2 is statistically significant.

2. Since R^2 = 0.87, 87% of the price variation is explained by the constructed regression model, which indicates its high quality.

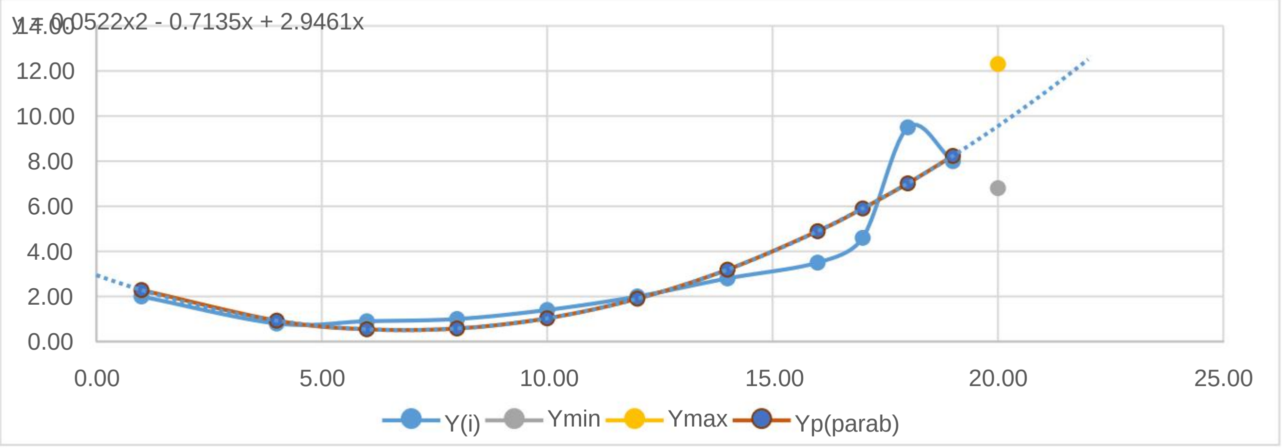
3. The coefficient for X^2 is 0.0522, which indicates growth prices at high sales volumes (scarcity effect).

4. A negative coefficient at X (–0.7135) indicates a decrease in price at small volumes.

5. Average forecast value of the growth of the performance indicator is ÿY = 2.7528, and the 95% confidence interval is within 6.8032 to 12.3089.

6. The elasticity coefficient K = –34.9334 indicates that with an increase in sales volume by 1%, the price decreases by an average of 34.93%, i.e. demand has an elastic nature.

The graph of the dependence of the quantity sold on the price per item will have looks like this:



Graph 3.2 Parabolic dependence of bakery data

3.2. Calculation using DATA ANALYSIS from the package

A note on the results: in the previous analysis, the model was selected from the assumption that the relationship between variables is nonlinear, in particular — parabolic. This means that the possibility of the existence of a priori was taken into account quadratic term, i.e., a second-degree model was constructed. Such a model allows you to detect nonlinear dependence, in particular, situations where with increasing X, Y first increases and then decreases (or vice versa). This approach was justified because the scatter plot showed a nonlinear nature placement of points.

However, the linear regression function in Excel (e.g., "Data Analysis ÿ Regression") automatically performs only linear modeling, i.e. searches for relationship of the form: Y=bX+a. This model does not take into account the quadratic (X^2) or higher powers of the variable, so Excel does not see the full dependency structure if it is actually parabolic. Therefore, the coefficients it gives reflect a simplified model that can be useful but less accurate in cases nonlinearity.

The data presented below will only confirm that the relationship between the above data not linear.

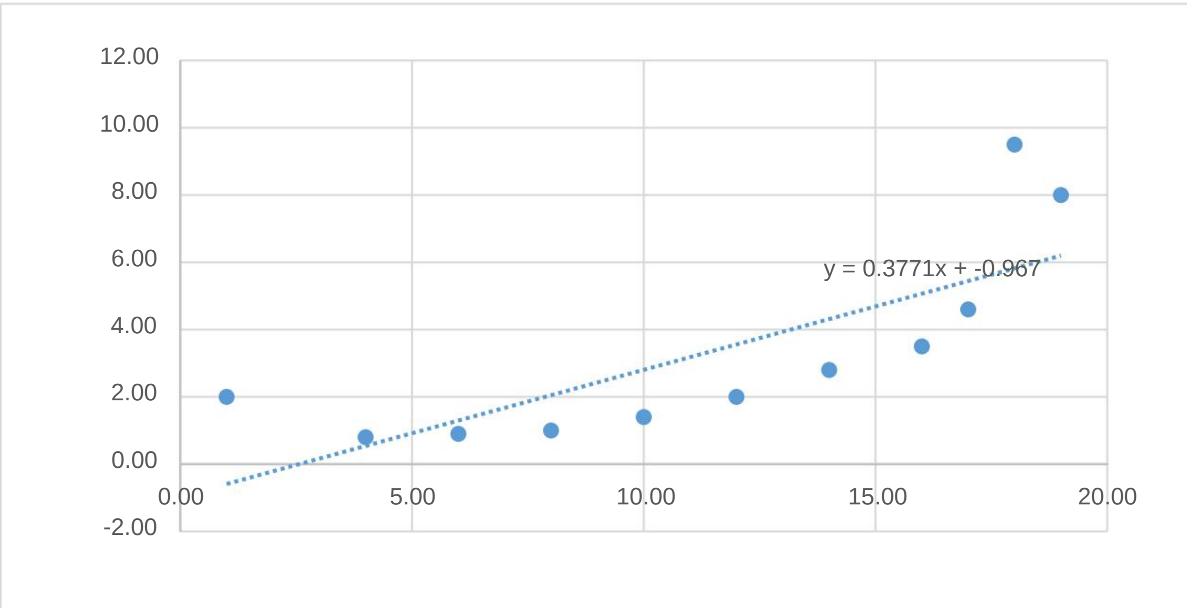


Chart 3.3 Linear data dependence

Table 3.6 Regression dependence using MS Excel

Regression statistics

Multiple R	0.774959586
R-squared	0.60056236
Normalized R-square	0.5561804
Standard error	1.962700368
Observations	11

Table 3.7 Analysis of variance using MS Excel

Dispersion analysis					
	df	*SS*	*MS*	*F*	*F value*
Regression	1	52.12662901	52.12662901	13.5316773	0.005086956
Remainder	9	34.66973462	3.852192736		
Total	10	86.79636364			

Table 3.8 Continuation of the analysis of variance using the MS Excel package

	Odds cents	*Standard What a mistake*	*t-statics tika*	*P-Significant yes*	*Lower e 95%*	*Upper e 95%*	*Lower 95.0%*	*Upper 95.0%*
Y-will cross we	0.967137897	1.306640209	0.740171541	0.478059149	3.922963405	1.988687611	3.922963405	1.988687611
Change naya X 1	0.377108135	0.10251563	3.678542823	0.005086956	0.145201668	0.609014602	0.145201668	0.609014602

Table 3.9 Output of balances using MS Excel

CONCLUSION RESIDUE			
Observation	*Predicted Y*	*Remains*	*Standard remains*

1	-0.590029762	2.590029762	1.391007578
2	0.541294643	0.258705357	0.138940918
3	1.295510913	0.395510913	-0.212414037
4	2.049727183	1.049727183	-0.563768991
5	2.803943452	1.403943452	-0.754005228
6	3.558159722	1.558159722	-0.836828987
7	4.312375992	1.512375992	-0.812240267
8	5.066592262	1.566592262	-0.841357787
9	5.443700397	0.843700397	-0.453119753
10	5.820808532	3.679191468	1.975955368
11	6.197916667	1.802083333	0.967831184

Since Fproz = 13.53 > Ftab, the regression model was constructed Y=ÿ0.9671+0.3771ÿX is adequate to the statistical data at the significance level 0.05. This means that there is a linear relationship between the variables under study. is statistically significant.

R^2 = 0.6006, i.e. 60.06% of the variation in the performance indicator explained by the variation of the factorial trait. In other words, the model explains a significant, though not dominant, part of the addiction.

CONCLUSIONS

As a result of a systematic analysis of the old bakery, which uses traditional recipes, a model has been developed that allows visualize and structure the processes taking place in a bakery. Model "black box" allowed us to focus on studying the interaction of the main bakery subsystems without the need to investigate the internal mechanisms each stage of production.

The analysis showed that the bakery system needs to be adapted to modern conditions, in particular, to new technological solutions and changes in the market. Important aspects that were identified during the modeling are scalability and ability to adapt to changing conditions. Process optimization is proposed, based on data analysis, will significantly improve efficiency production, while maintaining the uniqueness and quality of the products.

Further, based on this model, further implementation of the latest technologies and methods that will help increase competitiveness bakeries on the market. Thanks to the developed system, you can not only store traditions of baking, but also to improve it within the framework of modern business processes.

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LIST OF TABLES IN WORK

LIST OF DIAGRAMS IN WORK

LIST OF WORKING SCHEDULES