

Analysis and Forecasting of Management Decisions in Commercial Real Estate Management

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Abstract—The relevance and necessity of the problem of forecasting management decisions in the field of commercial real estate management is shown. A modified Huff model which is used to predict attendance commercial real estate and consumer appeal is shown. The main feature of the proposed model is its versatility in relation to the type and format of commercial real estate. The introduced convolution Q , describing the quality of the property, is a function of many variables, the set of which and the type of functional dependence is individual for each type of commercial real estate. The model example of sensitivity analysis complex evaluation to changes in the status of private criteria that can serve as the instrumental basis of the decision support system is given. Also, the model example of sensitivity analysis and search for the optimal strategy of economic entities of shopping and entertainment complexes is shown. Screen forms of multi-user system of support of making individual management decisions in the software environment RDS (Research of Dynamic Systems) are given.

Index Terms—decision support system, commercial real estate, property management

I. INTRODUCTION

The problem of managing commercial real estate, in particular shopping and entertainment complexes, has a high degree of uncertainty [1], [2]. The external source of this uncertainty is consumer preferences that affect the choice of visiting a shopping and entertainment complex [3]–[6]. In addition, high uncertainty is associated with the complexity of forecasting the results of management and business activities. Increasing competition and increasing territorial concentration of commercial real estate makes the information on the current and projected attendance of the property consumers for effective management of real estate and business activities on the basis of the commercial object visiting [7], [8].

The significance of the consequences of wrong management decisions puts forward the requirement for the development and implementation in practice of quantitative methods of forecasting and management with high accuracy and reliability properties.

II. THE NEED FOR FORECASTING THE PROBLEM OF MANAGEMENT DECISIONS IN THE FIELD OF COMMERCIAL REAL ESTATE MANAGEMENT

Let us consider the possible risks of inefficient management of the shopping and entertainment complex, for example, the implementation of an advertising campaign, accompanied by the provision of discounts on certain groups of goods.

It is advisable to carry out risk analysis using the method of determining the break-even point (Fig. 1) but based on determining cash flows (CF) from the number of visitors (n).

The advertising campaign is accompanied by an increase in total fixed costs (TFC) at the expense of funds allocated for advertising, and accordingly the total costs (TC). Providing discounts in turn leads to a decrease in the average revenue of the buyer (AR), which determines the angle of the straight line describing the total revenue (TR) (Fig. 1, b). The total variable cost (TVC) will remain unchanged.

As you can see in Fig. 1, sales profit (P) may be less even if the number of visitors increases. It is also obvious that the shift of n_{min} during marketing campaigns leads to an increasing need to predict the flow of buyers.

To predict the attendance of the commercial real estate object, the modified [9] Huff model (1) [10]–[12] can be used, which allows to estimate the consumer attractiveness of the commercial property:

$$A_{ij} = \frac{\{Q_j\}}{\{T_{ij}\}^{\lambda_k}}, \quad (1)$$

i – the sequence number of the buyer (the i -th consumer means the consumer located in the point of i); j – serial number of the commercial property; A_{ij} – the attractiveness of the j -th property for the i -th consumer; Q_j – the quality of the property; T_{ij} – time spent by the i -th consumer on the road to the j -th property; $\lambda \in [0; 1]$ – parameter reflecting the effect of different types of objects on the perceived time costs (this parameter is empirical); $\{\}$ – the numerical value of the parameter.

The time of commuting (T) of consumers from the place of residence to the commercial object has a significant impact on the assessment of consumer attractiveness to shopping and entertainment complexes. The so-called pedestrian-transport zones [13] and corresponding parameters λ are formed with respect to commercial real estate objects: for the first zone (from 45 to 80 min walk) – $\lambda = 0$; for the second zone (from 80 to 160 min walk) – $\lambda = 0.5$; for the third zone (over 160 min walk) – $\lambda = 1$. At the intersection of these zones, depending on the location of the studied commercial real estate objects, it is possible to allocate several sectors K (Fig. 2), each of which affects consumers differently commuting time to a particular property.

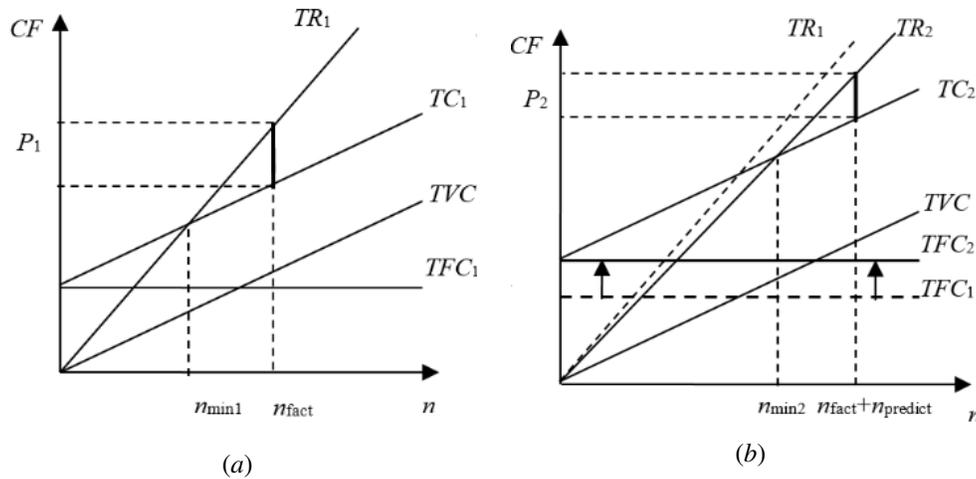


Fig. 1. Analysis of the sensitivity of cash flows of the shopping and entertainment complex from the number of visitors to (a) and after the implementation of (b) advertising campaign

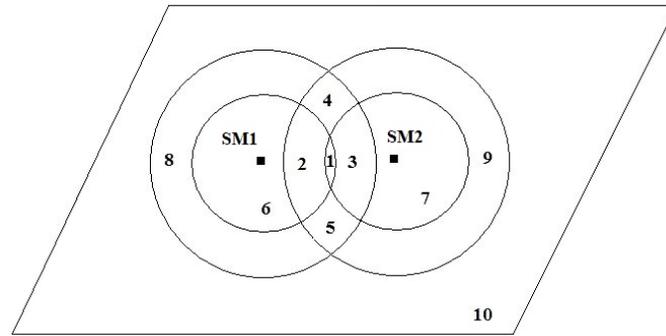


Fig. 2. Allocation of sectors by the example of two shopping and entertainment complexes (SM)

Having calculated, on the basis of the modified Huff model (1), the probability of a potential consumer's choice of a trade object (2):

$$P_{ij} = \frac{A_{ij}}{\sum_{j=1}^n A_{ij}}, \quad (2)$$

and knowing the number of visitors in each sector k , you can calculate the number of expected visitors (n) in the shopping mall:

$$n = \sum_{k=1}^K (P_{ij}^k \cdot N_k), \quad (3)$$

P_{ij}^k – the probability of visiting the i -th visitor from the k -th sector of the j -th property; N_k – number of residents of k -th sector; K – number of sectors for the example with two shopping malls: $K = 10$ (see Fig. 2).

By determining the expected number of visitors, you can calculate the approximate revenue (TR) based on the average receipt of the object (AR):

$$TR = n \cdot AR, \quad (4)$$

and can be determined by the total profit of retail and entertainment outlets of the shopping and entertainment complex:

$$Pr = TR - TFC(x_l) - TVC(x_l), \quad (5)$$

x_l – the status indicators for monitored parameters $l \in L$ commercial real estate; TFC – total fixed costs.

Total variable costs (TVC) determine the state of an object, that is, its quality $Q_j(x_{lj})$ and consumer appeal $A_{ij}(Q_j(x_{lj}), T_{ij}, \lambda(k))$.

The indicators of the effectiveness of management decisions can be the quality of the commercial property, its consumer attractiveness, the number of additional visitors, revenue or profit of retail and entertainment outlets, and the criterion of efficiency is the maximization of these indicators.

From the economic point of view, the effectiveness of the management of the shopping and entertainment complex should be considered from the point of view of profit. Thus, the problem of managing j -th shopping mall can be formulated

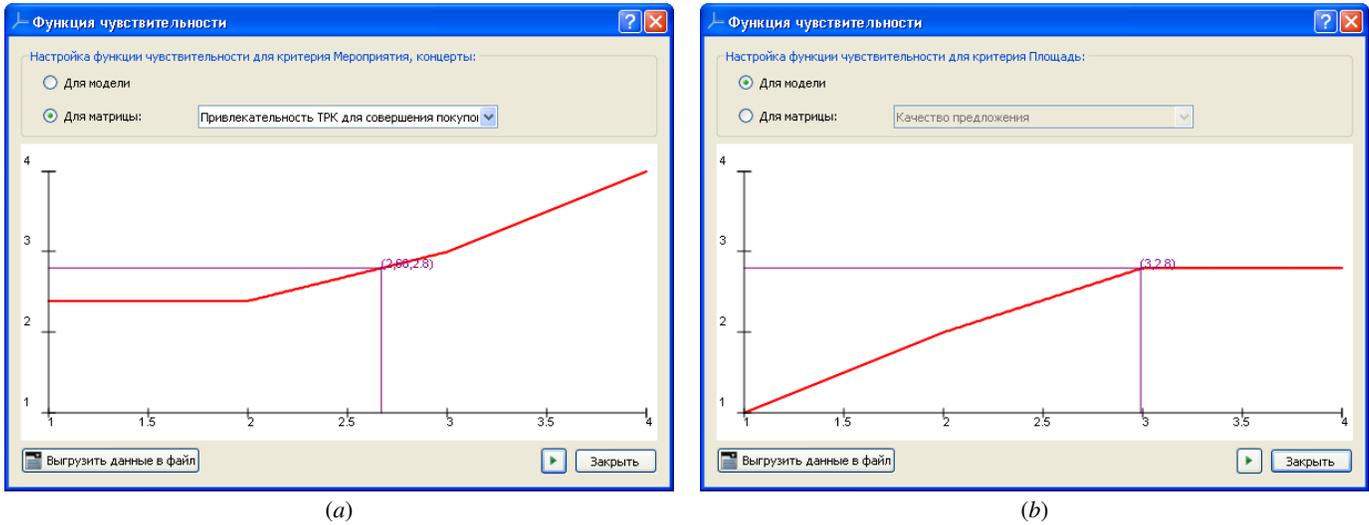


Fig. 3. An example of sensitivity functions showing the perspective direction (a) and the critical direction (b) of a shopping mall

as an optimization problem with the objective function:

$$\Pr_j(x_{l_j}) = \sum_{k=1}^K \left(\frac{\alpha \cdot \frac{Q_j(x_{l_j})}{T_{ij}^{\lambda(k)}}}{\sum_{j=1}^J \alpha \cdot \frac{Q_j(x_{l_j})}{T_{ij}^{\lambda(k)}}} \cdot N_k \right) \cdot AR - TFC(x_{l_j}) - TVC(x_{l_j}) \rightarrow \max, \quad (6)$$

with budget restriction on management:

$$TFC(x_{l_j}) + TVC(x_{l_j}) \leq B_j, \quad (7)$$

and the restriction on the set of permissible values of the controlled parameters $x_{l_j} \in X^l \subset R^l$, what is meaningful is interpreted as – find the permissible state of the controlled parameters x_{l_j} property to get the maximum profit in compliance with budget constraints.

III. A MODEL EXAMPLE OF ANALYSIS OF THE SENSITIVITY OF COMPLEX ASSESSMENT TO CHANGES IN THE STATE OF THE PARTICULAR CRITERION

One of the ways to study the effectiveness of management decisions is to analyze the sensitivity of the complex assessment to changes in the state of the particular criterion. In the case of sensitivity analysis of matrix mechanisms of complex estimation [14], the sensitivity functions are nonlinear and piecewise smooth, because the importance of the factors depends on the domain of determination; in qualimetric mechanisms the sensitivity functions are smooth. The functional capabilities of the Decon software [15] allow us to construct the sensitivity functions of the complex assessment to the change in the state of the particular criterion, which serves as the instrumental basis of the decision support system.

Building the sensitivity function, it is possible to define a perspective direction to improve the quality of the object (Fig. 3, a) and critical areas, which are characterized by the fact that the lack of management will lead to a passive deterioration

of the state of the private criterion and, accordingly, the quality of the commercial object (Fig. 3, b).

In property management practice there is such a concept as excessive utility, when the improvement of a separate criterion does not bring an effect to the improvement of the real estate object (Fig. 3, b). As a result, the cost of improving the private criterion should be considered ineffective, and the existing wear on this criterion is irreparable, since it is economically impractical to eliminate it.

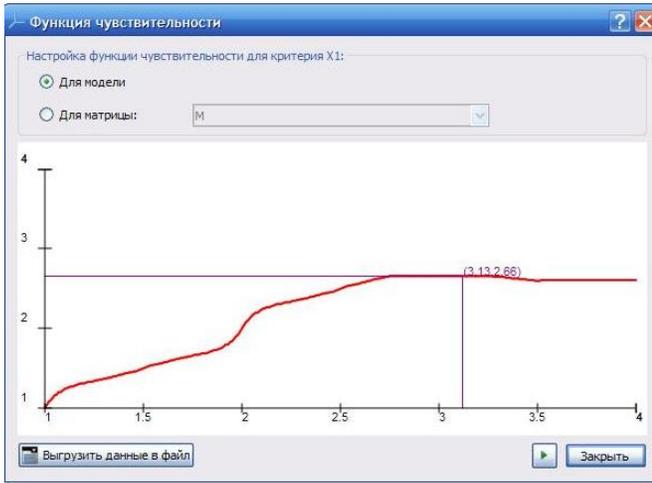
Using sensitivity analysis, not only such a known phenomenon as excessive utility can be identified, but also hidden utility (Fig. 4)

A sign of hidden utility is a situation in which a separate improvement of private criteria does not bring effect to the improvement of the quality of the shopping and entertainment complex (see Fig. 4, a) or has limited effect (see Fig. 4, b). The joint improvement of private criteria makes sense and is appropriate (see Fig. 4, c). As a result, the accumulated deterioration of private criteria (wear) can be considered disposable together, although some attempts to eliminate them are not effective, that is why this phenomenon was called hidden utility.

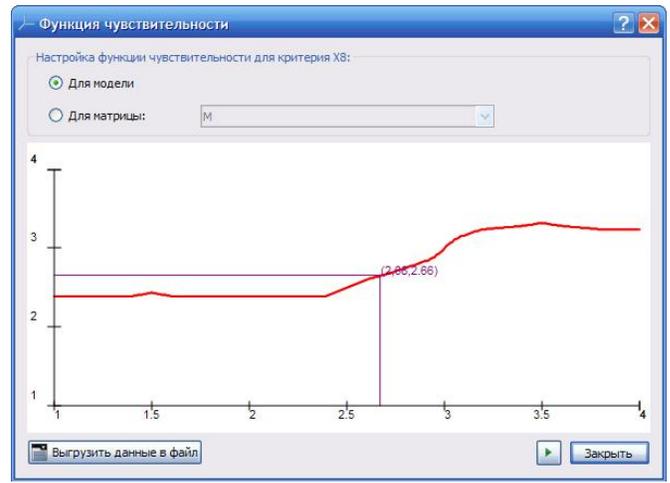
Using the above Decon software [15] we can carry out sensitivity analysis to evaluate the “Quality of object” based on the matrix mechanism. However, in accordance with the statement of the management problem (6), it is required to find not only the state delivering the maximum quality of the property, but the maximum profit. To do this, it is necessary to perform a sensitivity analysis of all the parameters [9] used in the model.

Figure 5, a shows the sensitivity functions of the attractiveness (A) of shopping and entertainment complexes defined by formula (1) for consumers living and working in different sectors, formed by the intersection of pedestrian transport zones (see Fig. 2).

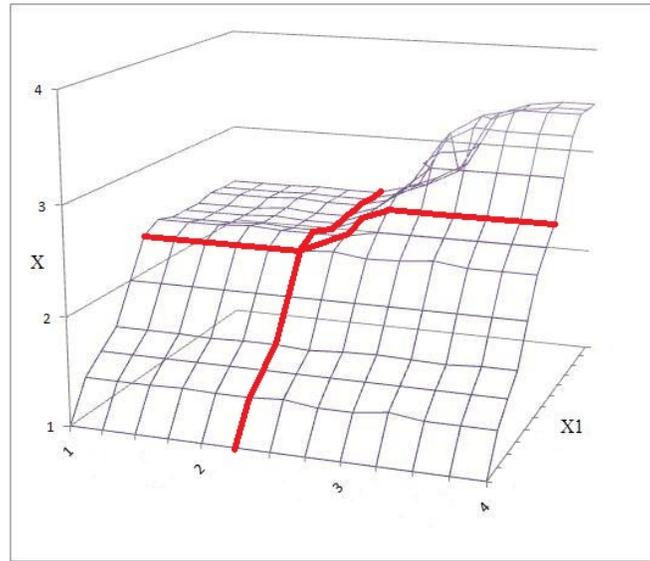
The probabilities of visiting the shopping and entertainment



(a)

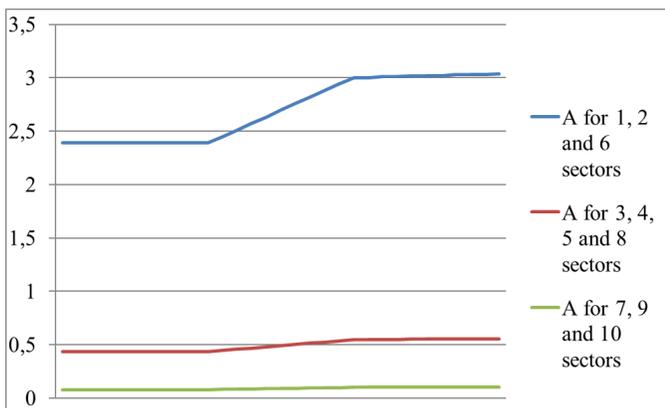


(b)

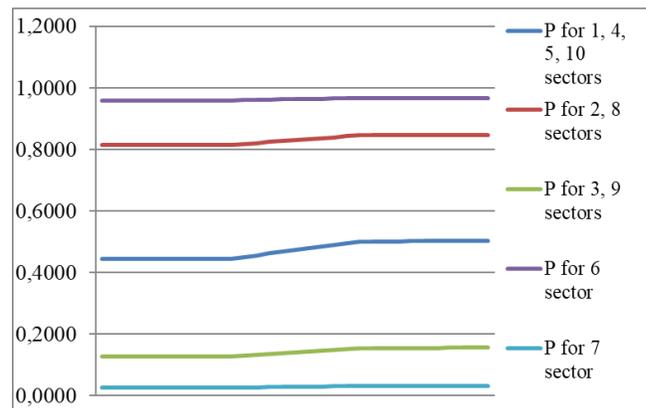


(c)

Fig. 4. An example of functions of sensitivity, showing a hidden utility



(a)



(b)

Fig. 5. Sensitivity functions: (a) – of the attractiveness of a trade object depending on the sectors formed by the intersection of pedestrian and transport zones; (b) – of the probabilities of consumers visiting the shopping facility depending on the sectors of their residence (by the example of the Coliseum shopping and entertainment complex in Perm)

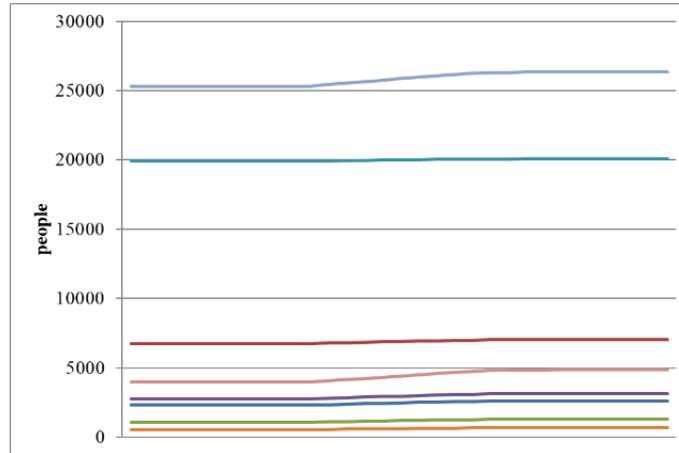


Fig. 6. Sensitivity functions showing the dependence of the expected number of visitors to the shopping mall to change the managed criterion depending on the sector of visitors' residence, by the example of the Coliseum shopping and entertainment complex in Perm

Note to Fig. 6: The Expected number of visitors from 10 sectors is not included in this graph for the sake of clarity of the number of visitors from 1–9 sectors.



Fig. 7. Sensitivity functions showing the dependence of the expected number of visitors to the change of the controlled criterion (a) and the expected income to the change of the controlled criterion (b), by the example of the Coliseum shopping and entertainment complex in Perm

complex by residents living in different sectors are calculated using the formula (4) and are presented below (Fig. 5, b).

To determine the potential number of buyers (Fig. 6) let us assume the number of persons living in different sectors (Fig. 6) and use the expression (3).

After receiving the data shown in Fig. 6 and 7, it is possible to solve the task (6) and to determine the dependence of the total profit of shopping and entertainment outlets of the shopping and entertainment complex (Fig. 8) changes in the managed criterion – quality of measures (X_8) – with the following initial data:

- quality of the competing object $Q_2 = 2.99$;
- values of criteria of the object under study: $X_1 = 3.13$, $X_2 = 2.83$, $X_3 = 3.62$, $X_4 = 3.47$, $X_5 = 2.39$, $X_6 = 3.2$, $X_7 = 3.16$, $X_8 = 2.68$;
- the average revenue of the buyer $AR = 750$ rubles';
- data on the number of potential buyers are given in Table I.

To determine the cost of changing the managed criterion as an assumption necessary for calculations, we take the following equation of the cost function (TC):

$$y = 0.08 \cdot x^2 + 150, \quad (8)$$

where 150 – the conditional value of fixed costs (TFC), thousand rubles'.

Figure 8 shows that the profit of economic entities may be less even if the number of visitors and buyers' increases. The optimal solution to the problem of management of the shopping and entertainment complex is such a distribution of the budget of economic entities to change the managed factors, which provides a maximum of their personal profit.

The search for the optimal management solution can be carried out using the proposed method of sensitivity analysis, with iterative use of which sequence of activities can be planned. Such a task is relevant in the context of a limited budget, as the cost of the program of successive activities can be distributed over time.

IV. SENSITIVITY ANALYSIS AND SEARCH FOR THE OPTIMAL STRATEGY OF ECONOMIC SUBJECTS OF SHOPPING AND ENTERTAINMENT COMPLEXES

Let us consider an example where the strategy of economic entities of a shopping and entertainment complex (SEC) depends on four options for the cost of changing the four managed criteria (Table II).

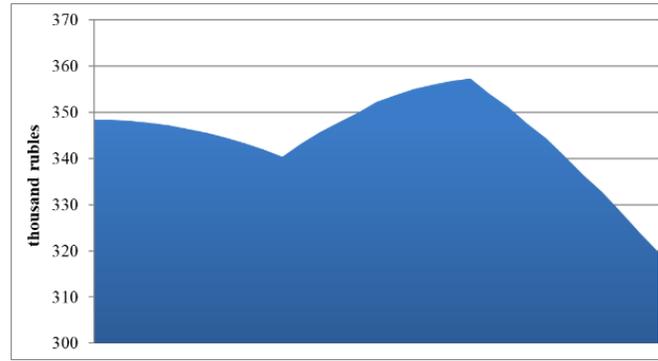


Fig. 8. The dependence of the total profit of the shopping (entertainment, etc.) shopping center premises on the change in the managed criterion, by the example of the Coliseum shopping and entertainment complex in Perm

TABLE I
THE NUMBER OF RESIDENTS IN THE SECTORS (FIG. 2)

sector number (k)	1	2	3	4	5	6	7	8	9	10
the number of residents in the sector (N_k)	5182	8292		6219		20729		31094		898619

Note to Table I: the number of residents in the sectors is taken conditionally to illustrate the solution of the management problem.

TABLE II
AN EXAMPLE OF HOW TO ALLOCATE COST OPTIONS TO MANAGE FOUR CRITERIA

Options for allocating management costs	advertising / brands	aesthetic appearance	quality of goods	events
	X_1	X_2	X_3	X_4
CF1	40	0	100	25
CF2	60	120	200	40
CF3	90	250	300	55
CF4	120	500	400	70

The quality of the object for this case will be calculated using a geometric weighted model:

$$Q = \prod_l Q_l(x_l)^{q_l} = Q_1(x_1)^{0.12} \times Q_2(x_2)^{0.15} \times Q_3(x_3)^{0.15} \times Q_4(x_4)^{0.12} \times Q_5(x_5)^{0.12} \times Q_6(x_6)^{0.15} \times Q_7(x_7)^{0.11} \times Q_8(x_8)^{0.08} \quad (9)$$

The number of strategies of each economic entity will be determined by the formula:

$$N_{\text{strategies}'} = n^m, \quad (10)$$

n – number of cost options for changing criteria; m – number of criteria (factors) that can be controlled by an economic entity.

Below (Fig. 9) it is shown how the optimal strategy of economic entities of the shopping and entertainment complex on the criterion of profit maximization depends on the

change in the level of consumption, which, on the one hand, reflects how many visitors make purchases in the shopping and entertainment complex (Customer Conversion Ratio – μ), and, on the other hand, is expressed in the average amount of purchases made by visitors to the shopping and entertainment complex (the average revenue – Ar). These factors describe changes in the external environment.

The sensitivity analysis shows (see Fig. 9) that with the growth of consumption it becomes profitable to invest in the development and promotion of the SEC, which is almost obvious, but the task of finding the optimal allocation of funds for the management of the SEC is not a trivial task and its solution is quite time-consuming, which needs the creation of a system of support for management decisions. It should also be noted that the Manager and tenants have different opportunities for the development and promotion of the SEC. For example, the quality of goods is a controlled factor on the part of tenants, and the aesthetic appearance can be changed by the Manager of the object as a whole, and the tenant(s) – a separate trading

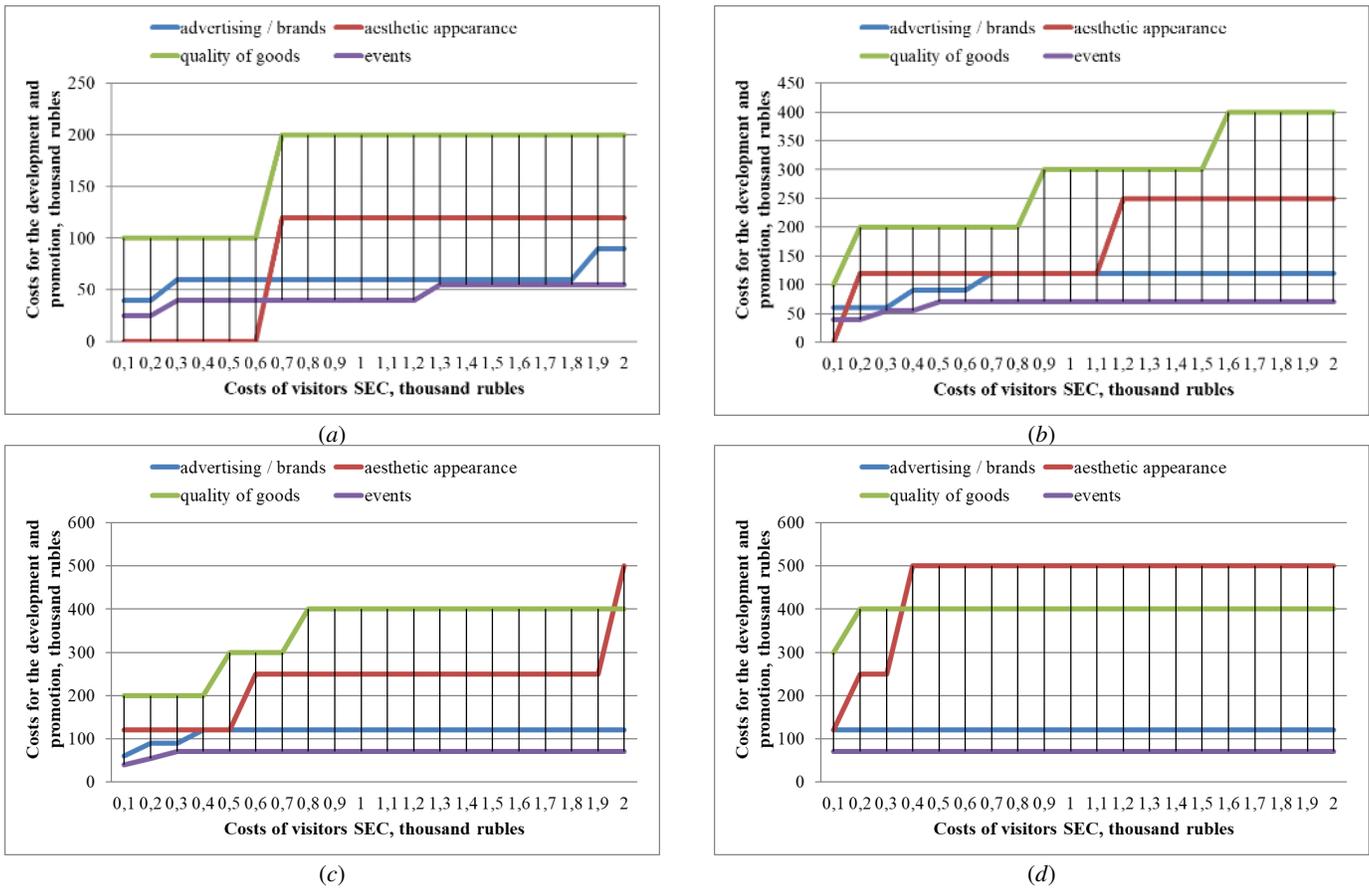


Fig. 9. Analysis of the sensitivity of the optimal strategy of economic entities of the SEC to the change in the average check at different conversion rates
Note to Fig. 9: (a) – at $\mu = 0.01$, each hundredth visitor of SEC makes a purchase; (b) – at $\mu = 0.05$, the purchase is made by every twentieth visitor of SEC; (c) – at $\mu = 0.1$, the purchase is made by every tenth visitor SEC; (d) – when $\mu = 0.5$, the purchase is made by every second visitor SEC.

or entertainment point(s). Therefore, a system of support for individual management decision-making is required.

V. MULTI-USER SUPPORT SYSTEM FOR MAKING INDIVIDUAL MANAGEMENT DECISIONS

RDS (Research of Dynamic Systems) software product [16] was chosen as the environment for the development of the system of support of individual management decisions, allowing to carry out simulation modeling and conduct business games with real people (Fig. 10).

The screen form of the Tenant (Fig. 11) differs from the Manager in that he has the additional opportunity to invest in the expansion of the range and increase the quality of goods, as well as to determine the prices of products and the amount of discounts. In the right part of the screen graphs of profit from the controlled factors are plotted.

VI. CONCLUSION

The decision obtained with the help of this system of management decision support corresponds to the situation when a separate economic entity acts individually, in order to achieve the maximum personal profit. However, decisions made by other participants of the economic system under study have an impact on the performance of all participants. A separate area of further research should be theoretical and game formulation and study of the problem of management of commercial real estate, taking into account the overlapping interests, including conflict.

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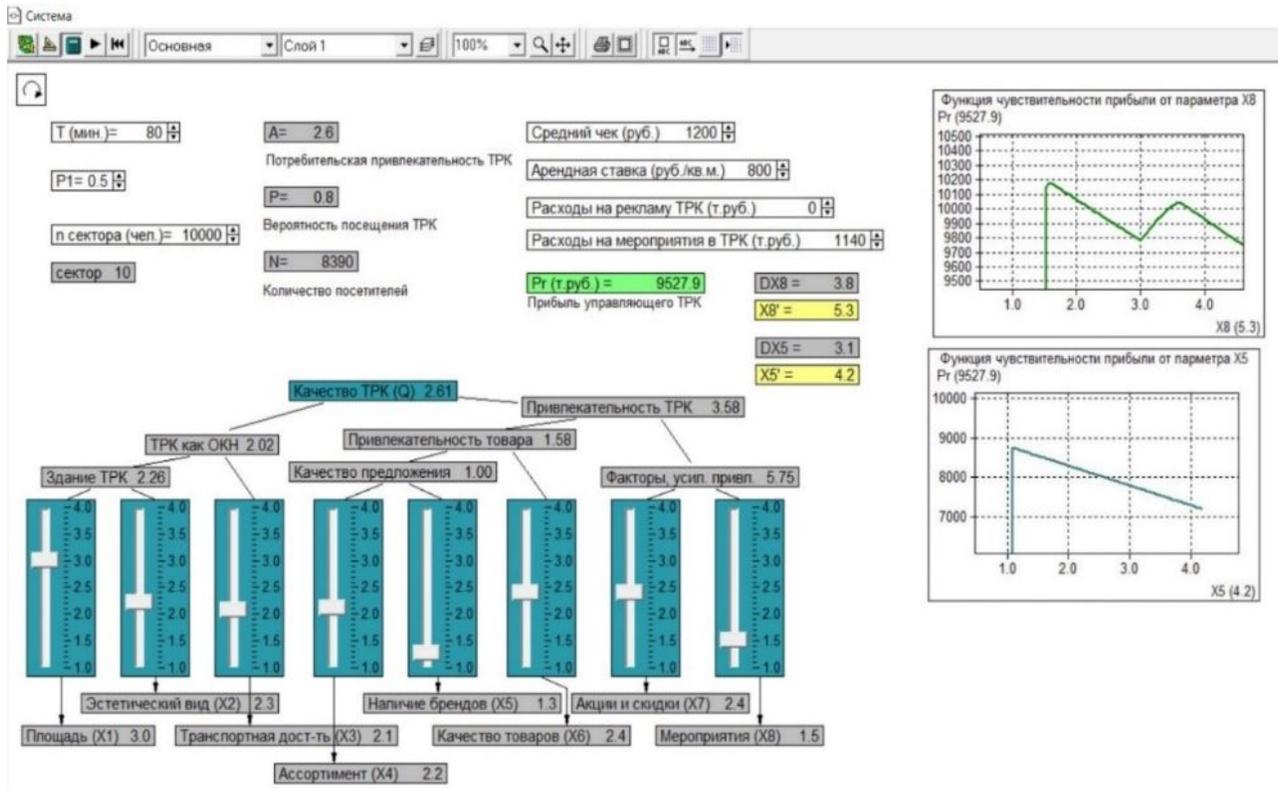


Fig. 10. Screen form of the Managers individual management decision support system in the RDS environment

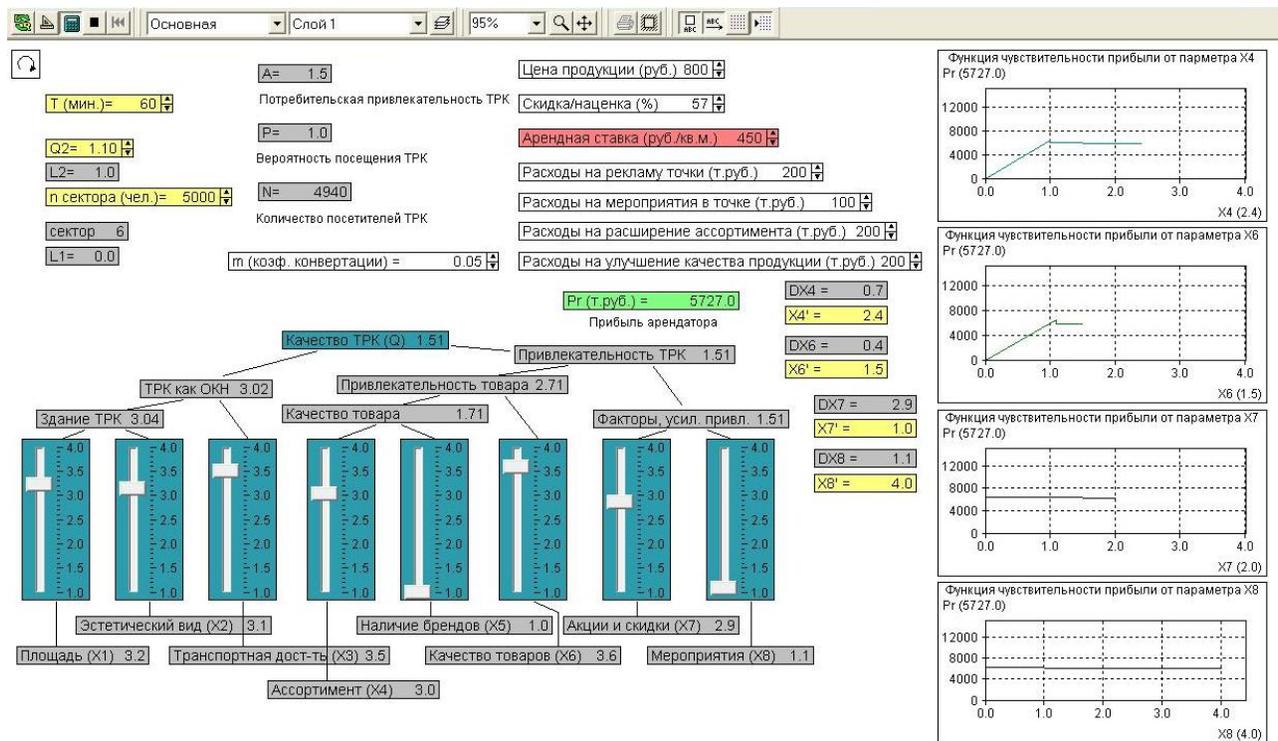


Fig. 11. Screen form of the Tenant's individual management decision support system in the RDS environment

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