Trade Services System Adaptation for Sustainable Development

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Abstract. Under market conditions, the trade services system in post-Soviet Russia, being one of the most important city infrastructures, loses its systematic and hierarchic consistency hence provoking the degradation of communicating transport systems and urban planning framework. This article describes the results of the research carried out to identify objects and object parameters that influence functioning of a locally significant trade services system. Based on the revealed consumer behaviour patterns, we propose methods to determine the optimal parameters of objects inside a locally significant trade services system.

Keywords: trade services, urban development, sustainable development, parameters of the centres.

1. Introduction

In post-Soviet period the hierarchic system of graded services [1] looks strongly deformed, as it has lost its systematic consistency and control components. New centres of trade activities kept emerging, like tumours on the body of the city. How could such a chaos provide for a sustainable development of the cities, as it was much more complicated to pull down a building, than to build it? This article considers organization of locally significant trade services to meet a weekly shopping need of the people, i.e. place trade services.

Today as never before, adaptation of the city systems and infrastructures to market conditions and ensuring their flexibility within the justifiably rigid and significant regulations is still of high scientific interest.

A prerequisite for the research described in this article is a hypothesis that correctly organized place trade services can enable the population to avoid regular shopping travels to neighbour and peripheral (outlying) districts for goods and services and supply the consumers with all they need within their residential areas [2].

2. Trade Services Infrastructure Modelling

2.1. W. Christaller's model

As is generally known, German Geographer W. Christaller developed a theoretical base for hierarchy of graded services in the middle of the 20th century [3]. Christaller proposed an optimal (ideal) system, where a city or district population could buy all necessary goods and services equidistantly on an evenly distributed area with a minimum number of trade facilities.
Christaller chose hexagons as an ideal theoretical form of service zones.

In the course of the model development, W. Christaller made a number of assumptions. In contemporary practices the assumptions, however, lead to mistakes in urban planning solutions. The biggest deviations occur due to uneven distribution of retail businesses within a place trade services system, and owing to the fact that parameters of single businesses fail to meet the system demand.

To adapt the theoretical W. Christaller’s model to up-to-date social and economic conditions it was decided to consider effect of quantitative and qualitative (influencing the emotional perception) parameters of a community centre or a single shopping centre on consumers, taking into account trade space area and assortment variety of offered goods.

2.2. Bipolar model of the trade services system

The main structural link between a consumer and a trade services system follows the bipolar model. A system of community services filled with trade and service businesses looks like a complex of consumer-attracting centres (magnets). In a chaos of offers, a consumer starts to ‘gravitate’ towards this or that centre. Given that, the attraction force depends on parameters of the source and on characteristics of the object attractiveness.

Identification (forecasting) of the centre spatial influence areals in the urban environment appears of interest. Boundaries of the centre influence areals present a position of certain consumer’s equilibrium state, when effects attracting to a purchase of goods from two closely located competing attraction centres are equivalent (figure 1).

![Figure 1. Consumer’s equilibrium position within the effect of two centres that determine the services centre influence zone boundaries.](image)

To identify an equilibrium state it was important to determine the services centre parameters and consumers’ individual features explaining their attraction to the centres. Based on analysis of foreign experience [4-15] and own research the following parameters were proposed:

a) for the services centres:
- size;
- assortment variety;
- qualitative parameters of attractiveness: aesthetic-architecture and figurative-emotion qualities, architectural expression, design, space layout, set of complementary services;

b) for consumers:
- payment ability;
- consumption behaviour under existing social and economic conditions.

3. Research of Community Behaviour Algorithms in Trade Services

Following the hypothetic suppositions, we carried out a field survey [15]. Research of the dependence between the wage and the goods assortment variety showed that the higher the income the lower were expenses for food and higher the ones for non-food goods and savings. However, dynamics of changes was insignificant and the absolute value of expenses grew proportionally to the income.
Obviously, the absolute value of expenses for food and non-food goods show growth, however, an individual cannot consume more than his or her physical ability or need. Consequently, increase in expenses goes towards better choice, higher quality and, as a result, to higher prices. The diagram below (Figure 2) shows a growth in attraction to a better-choice supermarket depending on income. It illustrates consumer’s behaviour trends versus qualitative characteristics of the services centres.

In addition to that, the survey results allow concluding that in case of income growth the consumers agree to travel longer distances to buy foodstuffs. Unlike the principle accepted in West European practices, where 75% of consumers should be serviced within their residential districts (reasonable functioning of place trade services system) [17-19], in Russian metropolitan cities (such as Yekaterinburg), this number does not exceed 54%.

Research of assortment-to-distance and shopping-space-to-distance functions confirms the following dependences accepted in West-European practices of trade services system administration:

- direct dependence between the assortment variety and the distance a consumer is prepared to travel (Figure 3);
- dependence of coverage radius of a shopping centre/trade business on foodstuffs shopping area: the larger the space the longer distance a consumer is prepared to travel to buy them (see Figure 3)

![Figure 2](image2.png)

**Figure 2.** Effect of consumer’s wage on shopping travels to better-choice supermarket/discounter.

![Figure 3](image3.png)

**Figure 3.** Influence of the shopping space (at the left) and the goods variety (at the right) on the distance a consumer is prepared to travel to buy foodstuffs.
The revealed patterns can be generalised as the following behaviour algorithms:

- the higher payment ability, the higher is the interest to better choice of foodstuffs;
- the higher the payment ability, the longer distances a consumer is ready to travel for shopping; given that, the consumers’ choice will not be in favour of a supermarket being comparable to the one located in their place. A consumer’s choice will always direct towards the better-choice shopping mall or a large shopping centre with the best assortment variety and prevailing qualitative parameters (architecture, space layout, availability of complementary services). At the same time, 54% of residential district population keep to place trade services;

- the larger the shopping centre space, the longer distance a consumer is prepared to travel (quantitative indicator);
- the better the assortment in a place trade services centre, the longer distances a consumer is prepared to travel there for shopping (quantitative indicator);
- non-quantitative characteristics of the trade services centre can also influence a consumer’s attraction, i.e. attractiveness of the centre and consumption behaviour of people under existing social and economic conditions.

4. Methods of Trade Services Regulation in Urban Development

In the proposed bipolar model (Figure 1), the following three accepted arguments of centres \( C_1 \) and \( C_2 \) influence the position of the boundary points:

- areas of trade space \( (S) \),
- assortment variety \( (A) \),
- parameters of centre attractiveness \( (V) \).

To construct graphically the space influence zones of everyday services centres in a residential district (search for their areas \( S_c \)) and, thereby, to solve the ‘opposite’ set problem, the influence zone boundary points are determined, first of all, on the lines that connect the centres of the same hierarchic level or of the same type of business.

In the general view, the sought-for value \( R_1 \) (or \( R_2 \)) represent a function of the three arguments characterising a services centre attractiveness and a distance between the competing centres: area of trade space \( (S) \), assortment variety \( (A) \), centre attractiveness \( (V) \). Solution of the problem can confine to identification of three influence weight coefficients \( (K_i) \) for one of the two centres. The weight coefficients in bipolar interaction model depend on parameters of both centres. Formula 1 is an example of identifying centre \( C_1 \) weight coefficient by the trade area parameter. Identification of weight coefficient for a centre trade area comes from direct ratio of trade areas of the centres \( (S_1, S_2) \):

\[
K_{S_1} = S_1 / (S_1 + S_2)
\]

To determine influence of attractiveness (in this case, parameter \( K_v \)) is a problem, which is not subject to easy mathematical interpretation. The notion ‘attractiveness’ itself implies a great share of emotional perception of an object. To formalise the problem we propose to use a system of points granted to an object (in this case, to a centre of services) depending on existence of certain attributes: availability of associated social-and-cultural service organizations, architectural and space layout parameters, design, etc. To score up the points (with the help of experts’ appraisals) for a centre we propose to use actual statistic data that are subject to adjustment owing to regular monitoring of influence of the centre qualitative parameters on its attractiveness.

Having accepted that all three arguments are of equal weight, final \( R_1 \) can be determined as a mean arithmetic value of the three results (Formula 2).

\[
R_i = \frac{\sum_{i=S,A,V} K_i \cdot R}{3}
\]

where \( R \) – is the distance between two centres.
Upon determination of the boundary points on the segments connecting the centres of services, it becomes possible to construct the polygon influence-zone areals (Figure 4). The normal in the given point to the line connecting the centres determines a polygon side for the obtained distribution.

![Figure 4](image)

**Figure 4.** Construction of the centre influence areals resulted from search for boundary positions of a consumer (adaptation of W. Christaller’s theoretical model).

Having calculated the number of population in a designed centre influence zone ($N_c$), and being aware of a consumer’s payment ability within the zone ($P_{(food)}$), and average efficiency of a trade space square meter of the businesses ($Tm_{(food)}$) in the centre, it is possible to calculate a demand for trade space ($S_{(food)}$) for a centre of services.

Formula 3 below is an example for foodstuff supermarkets:

$$S_{(food)} = N_c \cdot P_{(food)} / Tm_{(food)}$$  \hspace{1cm} (3)

Comparing the demanded and actual trade areas, and taking into account a prospective city space development, it becomes possible to conclude whether it is necessary to increase or decrease a centre’s services zone. The proposed methods allow achieving this by control of competing centres’ trade areas within the limits of the bipolar model, as well as by assortment variety and attractiveness parameters.

It should be noted that it does not mean an imposed prohibition of trade activities and, thereby, interfering in the sphere of private property. It means that there observed a conceptual degradation of excessively big centres. The actual changes can occur in the course of further control activities to restrict new intentions. The latter finds wide and efficient practices in West Europe; however, it does not relate to the authors’ developments.

5. **Conclusions**

As the main means of adaptation of a place trade services system, we propose integration of single trade businesses into urban environment. To ensure harmonious and correct integration of the trade services objects it is important to restrict and regulate such trade object parameters as trade space area, goods assortment and attractiveness.

In the course of time, the described methods of control will enable to construct a hierarchic system of place services meeting the interests of participants. A well-structured, strong and dynamically controlled place services system will definitely favour progressive development of city infrastructures communicating with it, including transport.

The proposed methods can serve as a tool enabling to simulate status of a place services system and to design its restructuring project (concept) to target harmonious and sustainable development of a city infrastructure and humanization of residential district environment as a whole.

Use of such control will make it possible to add and expand urban development regulations, construction and land use rules, and other documents required in territorial planning and management practices. Thoughtful attitude to integration of trade into city environment will enable to avoid many negative effects from both the engineering-and-technical side and architectural-and-artistic aspect (for example, a discounter’s red facades made of corrugated sheet in the main city avenue).

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