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A PERCEPTUAL-BEHAVIOURAL APPROACH WITH NON-PARAMETRIC EXPERIMENTAL COEFFICIENT FOR URBAN PARKING BUSINESS DESIGN

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Abstract: *Transportation science and integrated logistics of passengers in the cities provide a detailed study of the movements both on entry to the urban areas than within them. Parking lots are, very often, places of exchange between the motorized and the pedestrian or cycling mode, or between individual and collective motorized modes. As the modern urban civilization is known by its impetuous car parking expansion it becomes essential to design the parking lots bearing in mind the needs of those who will really use them and not referring to the political lobbies in the city administration.*

The study of parking lot in terms of business and financial design, planning and management after the construction needs is a more accurate determination of the experimental parameters, which enable choice of the model to minimize the uncertainty of the data that will define the revenues according to the Project Financing procedures.

Key words: *user behaviour, parking choice, market for parking, parking modelling, Project Financing for parking*

1. Introduction

The urban car parking lots become the opportunities for urban communities, wherever there is a shortage of parking lots and the pricing and banning traffic measures are adopted at the same time in order to promote the parking organized for the benefit of the systematic integration of stopping with the local road public transport, i.e. the park and ride solution (Abdelwahab, 1998; Feeney, 1989; Mom, 2015; Reisch & Thøgersen, 2015; Marcacci, 2015).

The public administration and the private organisations favour the construction and the use of the car parking lots in a specific area, including those on the road, in an increasingly competitive environment.

Before assuming to the investigations needed in order to describe the demand for transport it is necessary to understand which one is inherent for the demand of car parking as well as its shares currently carried on the roads and within the areas open to the public. In particular, it is necessary to describe this demand in terms of quantity (number of parked cars for specific periods of time, daily rotations of the parking for specific areas – as in Pleskac, Diederich, & Wallsten, 2015 - etc.) and quality (residents, employees, visitors, etc.) adopting the methods of specific survey, sampling or referenced to the universe. Thus, it is absolutely essential to conduct the investigations to photograph the unique characteristics of parking demand, both in qualitative and quantitative terms. Moreover, the relationship between the parking lots and all the other components of mobility from the local public transport to the goods transport should be taken into account. It is not possible to assess the parking requirements in the urban environment in its entirety as it is of little use to have a high supply of parking lots in the suburbs when parking demand is concentrated in the historic center or in around-center areas: and this consideration is much more true since the greater the size of the cities in the radial direction.

2. Method of modelling approach: use of a multidimensional model for urban parking

When we use a general model for the urban park, as a close equivalence between the aggregate of entropic maximization and disaggregated microeconomic approach of the multinomial *Logit model* (Leonardi, 1985), it is adopted a multinomial logit function (GLM-class of generalized linear models) adapted to transport costs/service levels (Watling & Cantarella, 2014), under the iso-cost to shadow prices, aimed at parking as perceived (Ottomanelli, & Sassanelli, 2011) which is expressed, in general, as:

$$P_{ij}^h = \frac{T_{ij}^h}{T_{ij}} = \frac{e^{-\left(\beta C_{ij}^h\right)}}{\sum_k e^{-\left(\beta C_{ij}^k\right)}} \qquad (1)$$

where:

- $h = 1,2,.. M$ [M = modal cut[1]];
- k is referred to a generic way of displacement among the m alternative ways considered until the parking stalls;
- P_{ij}^h the fraction of displacements T between the zones[2] i and j that took place with the mode h;
- T_{ij}^h given by $e^{-\left(\beta C_{ij}^h\right)}$;
- T_{ij} given by $\sum_k e^{-\left(\beta C_{ij}^k\right)}$;
- C_{ij}^h a composite function of the characteristics related to the displacement with the same form of displacement h between the zones i and j (site staging/parking area);
- C_{ij}^K a composite function of the characteristics related to the displacement with the generic form of displacement k between the zones i and j (Bieniek, 2014).

The hypothesis of reduction in the probability $q(z)$ of choosing a parking solution rather than another with increasing time displacement with respect to the parking lot, being estimated with:

$$q(z) = \frac{\omega_1}{\omega_1 + \omega_2 * e^{-\alpha * z}} \qquad (2)$$

where:

- $z = t^2 - t^1$ - it represents the difference in travel time between the two parking lots;
- ω_1 - cost of the closest parking 1 (also in terms of the bid to stop illegal or elusive);
- ω_2 - represents the cost of the parking 2 (most expensive cars in regime iso-cost to shadow prices);
- α: an experimental parameter that correlates the universe of "accessory" variables of the stopping as perceived by the consumer: comfort, safety, accessibility, flexibility, inter-modality, pollution, etc. (Arnott, 2006).

Solving the equation (2) we get:

$$q(z) = \frac{\omega_1}{\omega_1 + \omega_2 * e^{-\alpha*(t_2 - t_1)}} = \frac{\omega_1}{\omega_1 + \dfrac{\omega_2}{e^{\alpha*(t_2 - t_1)}}} \qquad (3)$$

where:

- $e^{-\alpha*(t_2 - t_1)}$ - represents the virtual impedant factor;
- $-\alpha * (t_2 - t_1)$ - represents the actual time of travelling (on foot) between the choice of parking.

The minutes, time differences mode, which make up the exponent e are processed in whole form and not with splits in seconds, since, by the consumer, perceived (Ferrarese, 2015), for the purposes of transport, only the first minute.

For the feasibility study of the parking project we propose to use the discrete choice model, considered as one of the most simple and precise for the design

[1] The objective of the cutting phase is to determine the modal value M_{ij}^{km} or the proportion of displacements made by individuals of the k^{th} class, from the area i to the area j, with the mode of transportation m, defined as the value T_{ij}^k. And to estimate the proportions M_{ij}^{km} we use the probabilistic models. Usually, in the literature we use two types of models: the first ones are relative to analysis of aggregate type (separation models), the latter are turning to unbundled facilities (choice way models or *modal choice*).

[2] "The most common approach to treat space is to divide study areas into zones and to code them, together with transport networks, in a form suitable for processing with the aid of computer programs. In some cases, study areas can be simplified assuming that the zones of interest form a corridor which can be collapsed into a linear form. However, different methods for treating distance and for allocating origins and destinations (and their attributes) over space are an essential element in transport analysis" (de Dios Ortuzar, & Willumsen, 2011, pp. 3-4).

calculations, defining α experimental coefficient as the following formula:

$$\alpha = \left[\Psi * \Theta * \left(\frac{A+O}{2} \right) \right]^{-1} \quad (4)$$

with the following ratios:
- Ψ - percentage utility ratio;
- Θ - percentage positioning of the parking lot ratio;
- A - percentage attractiveness of the segments ratio[3];
- O - percentage ability to compete in the parking lot ratio;

The new generalized multinomial logit equation, starting from (2) that will be applied to multi-dimensional analysis, for target segments, is:

$$q(z) = \frac{\omega_1}{\omega_1 + \omega_2 * e^{-\alpha*(t_2 - t_1)}} = \\ = \frac{\omega_1}{\omega_1 + \frac{\omega_2}{e^{\alpha*(t_2-t_1)}}} = \frac{\omega_1}{\omega_1 + \frac{\omega_2}{e^{\left\{ \frac{(t_2-t_1)}{\left[\Psi*\Theta*\left(\frac{A+O}{2} \right) \right]} \right\}}}} \quad (5)$$

where:
- ω_1 - that is usually the cost of transportation with the relative level of service (as in Li Donni, 1991, pp. 126-127) recognized as the most convenient for the consumer; here it is the level of service infrastructure of the parking closest to residential users given by the cars actually chosen (also in terms of illegal or elusive parking);
- ω_2 - that is usually the cost of transportation with the level/quality of service perceived as only apparently less than ω_1, for the consumer (ibidem); here it represents the level of service infrastructure of the parking consisting of parking spaces provided in the parking manufactured for residential, tourist, business, study and recreation parking;
- $e^{-\left[\Psi*\Theta*\left(\frac{A+O}{2} \right) \right]^{-1} * (t_2 - t_1)}$ - represents the virtual impedential factor, usually set as equal to an exponential inverse function of the travel time (for walking distance, in our case, as in Mieścicki, Daszczuk, 2013; de Dios Ortuzar & Willumsen, 2011, p. 317) of a residential, tourist, business, study and recreation parking, with the correct level of service;
- $-\left[\Psi*\Theta*\left(\frac{A+O}{2} \right) \right]^{-1} * (t_2 - t_1)$ - represents the actual time-walking between the choice of parking - alternatively - closest (t_1) and farthest (t_2) - made by the residential, tourist, business, study and recreation users; the first is perceived as the best in terms of comfort, flexibility, overall comfort, and the second is perceived as inferior, though much safer and less polluting made by the decision maker;
- $-\left[\Psi*\Theta*\left(\frac{A+O}{2} \right) \right]^{-1}$ - is a parameter that correlates in a statistical sense, utility (O'Kelly, 2010), positioning, ability to compete, attractiveness of segments to be taken (Xu, 2015).

Thus, by adopting the multinominal logit function with α experimental coefficient novelty we allow to determine more accurately the experimental parameters in order to minimize the uncertainty in the parking financial project.

3. Discussion: a joint analysis environment for the optimization of the urban parking

3.1. The comparison and selection of target segments for the study of urban parking

The parking is a severe constraint in the choices of how to conduct the shift and the final destination of the decision-maker, especially on the motivations (Weinberger & Karlin-Resnick, 2015) to move if it is not bound to a specific destination for a specified reason (such as commuting).

To arrive at an analysis of behavioural consumer choice (Oppenheimer & Kelso, 2015), in order to represent segmentation for the purposes of the survey, we find that the behaviour of the users of

[3] A and O with compensatory comparison and additive or linear rule (Tidwell, 2015) and homogeneous importance (Hess & Chorus, 2015)

stalls car for the urban parking can be divided as shown:

a) the decision-maker looks through the various options to stop those that can guarantee a shelter in parking areas very near to their final destination;
b) the decision-maker seeks, first, the spaces closest to the destination as it deems to be "employable" even for a very short time and in conditions of illegality or tax avoidance (e.g. stalls specialized for the disabled, or the "yellow-blue" stalls reserved for residents from 20:00 to 7:00 and "yellow" ones for the unloading of goods);
c) the decision-maker in his value system covers a short-term parking, if it can't find a free place, opt for a stall near his destination, accepts the risk of a break type of illegal or elusive parking.
d) the decision-maker is directed to the farthest zone, albeit with an adequate supply of parking lot, not without having first experienced an attempt to find a free place in the proximity of their destination;
e) the decision-maker that will prove especially sensitive to the cost savings, seeks shelter also to more distant areas compared to their destination, but in any case in which it has guaranteed to find a free parking, better low fare or if illegal;
f) the decision-maker who does not like a break away from the destination (including any volumes from shopping to carry with you) starts to wander aimlessly around their destination until he finds a place available at the lowest possible cost, generating a dynamic rest of quasi-cyclic (nomadic) type.

To properly define the parameter that correlates in a behavioural and market oriented sense, utility, positioning, ability to compete, attractiveness of consumers, to be taken, it is necessary to adopt the techniques of marketing management analysis and, particularly, the segmentation of the targets, the population part interested in the parking.

The process of segmentation includes the division of a market into individual units (targets) which are then re-agglomerated on the basis of variables in the social groups and economic strata, more or less wide, are called just segments.

The segmentation process is divided into four phases:

1) division of the market in simple or complex individuality;
2) re-aggregation of the simple or complex target on the basis of known variables;
3) creation of significant segments;
4) identification of real segments - or direct, or primary; of potential segments – or indirect, or secondary; the definition of extended segments, those composed of individuals or groups, "spot" or "individual".

The division of the market into segments is done by using the different bases or the segmentation variables such as:

- geographical spread in: geographical area; population; climate;
- socio-demographic spread in: age; sex; members of the family; education; ideology; employment; income;
- psychographic spread in: social stratum; lifestyle; personality;
- behavioural spread in: buying behaviour (sensitivity to quality, price sensitivity ...); buying attitude (positive, negative, ...); awareness (informed, uninformed ...); brand loyalty.

The segmentation techniques derived from the research methodology and statistics are based on two types of approaches:

- aggregation method;
- method of disaggregation with clustering based models or with the flexible segmentation as
    - *advanced cluster analysis;*
    - *conjoint analysis*.

A segment, to be considered attractive, must be uniform; it must have a significant economic dimension (even potential); it must be accessible (in terms of resources and competences) and it must be defensible from competitors.

Therefore, the segmentation of the target potential users of the parking lot is:

- a process to search for viable and competitive advantage;
- creative and innovative and it is defined by the needs of the application and not by the companies;
- (often) an iterative process;
- periodically examined.

The segmentation is given by the narrower consumer groups:

- with similar needs,
- that can be identified,
- that could be targeted,
- that has a specific marketing mix,

and that produces segments:

- measurable;
- accessible;
- substantial;
- with the remarkably similar needs, within the segment, compared to the needs of other segments.

In order to conduct the process of comparison and selection of target segments we must activate the following actions:

- to identify the target segments in urban and non-urban;
- to establish the evaluation criteria:
- to give the attractiveness of each segment;
- to determine the strengths and weaknesses of the management in the selected segments;
- to determine the value to be given to the criteria;
- to define the score for a criteria;
- to give a score of attractiveness for each segment;
- to give a score to the strength and weaknesses of the company management (= ability to compete) and of the major competitors for management relating to each target segment.

If the segments of clear attractiveness do not emerge, it is necessary:

- to review/to change values-scores;
- to review/to modify criteria;
- to review/to modify segmentation;

to abandon the market sector in order to review/to modify strategy.

3.2. Context of application: ratios for a definition of α experimental coefficient

3.2.1. A study design for utility ratio Ψ

In order to study the urban parking, in this case, we prefer a conjoint behavioural analysis that consists of a Conjoint Analysis Incomplete Profile - CAIP (as in Green, Krieger & Wind, 2001) -defining the utility ratio Ψ in terms of attributes that categorize alternatives. With regard to the decision-maker, he would derive its utility from the attributes, directly and not directly, having to define the preference for a good or service. In this case, the choice between the alternatives is a choice between the attributes and, thus, it is calculated the utility ratio of the individual characteristics which helps to determine the choice.

With the incomplete (partial) profile system, which is also suitable for complex products, the preferences expressed concern only a subset of the possible combinations. The proposed profiles are different for each respondent, but overall all profiles are assessed by a portion of the respondents.

In CAIP method the choice of the numerousness of factors descends from the hypothesis formulated on the function form of the considered response, which can be of the additive type, that is one with main effects, or of mixed type and with interactive effects (Rao V.R , 2014).

In the *additive* model, with separate coefficients (or part-worths) for each factor mode, it is estimated a coefficient of “partial utility" and, in addition, it is also estimated a coefficient for each iteration of modes. So, if considering Q factors with m_1, m_2, m_3, .., m_q mode (qualitative or quantitative), the number of possible combinations for a complete expressible factorial design is given by the product $\prod_{q=1}^{Q} m_q$. The general utility coefficients, to estimate in the model for main effects (of a partial fractionation), are amounted to:

$$\sum m_{q-1}\Big|_{q=1}^{Q} = \sum m_q - Q\Big|_{q=1}^{Q} \quad (6)$$

The advantages of a partial fractionation design (John, 1998) is that which enables to estimate some interactions among the attributes and the specific fraction to be chosen depending on interview time (and implicitly of the research budget) and on the nature of the interactions.

For the experimental stages in the field, it is preferred to consider always a subset of combinations to choose with the stochastic criterion, in order to extend the estimated parameters also for the product profiles which are not subject to the service evaluation ratio. The factorial study design allows us to estimate the main effects and the effects of the interaction of the various modes of the attributes of the product that is particularly burdensome for the researcher, and, among the fractionated plans, through an additive model, the orthogonal design allows the estimation of the main effects, i.e., of the partial utilities ratio of the levels of the various attributes. The fractionated plans, however, do not produce an estimate of the parameters of the factors interaction effects, which are often "confused" with some main effects (Jourdan, 2015).

The composition model interprets the formation of preferences of a decider as individual utility function, in its turn interpreted as function of the mode or of the levels of the relevant characteristics of the service. So, when a specific profile for a service encounters more often the approval of a decider, than its use will provide more the Lancaster's utility.

The *additive utility model*, in which the partial utilities of the individual levels of each attribute are summed to obtain the overall utility of a profile, is the most widely used by researchers.

In the metric Conjoint Analysis (Louviere, 1988) the response variable Ų, estimated by the function of non-linear partial utility, is viewed as an expression of preference service evaluation ratios of each interviewee and it is used in a direct way to estimate the parameters using a multiple linear regression.

So, if for a generic consumer *i* with the explanatory qualitative variables given as the factors and for the dummy, we have:

$$d_{mkq} = \begin{cases} 1 & - \quad \text{if a profile } m \text{ contemplates the attribute } k \text{ with the level } q \\ 0 & - \quad \text{otherwise} \end{cases}$$

where:

- m - is the combination m = 1, 2, ..., M
- k -is the level of the factor k, q = 1, 2, ..., Q_k

the partial utility function of the factor k for the profile m is represented by the following:

$$Ų_{ik} = \sum_{q=1}^{Q_k} W_{ikq} d_{mkq} \qquad (7)$$

where:

- $Ų_{ik}$ - indicates the utility for the *i-th* respondent produced by the factor *k*;
- W_{ikq} - is the expected regression coefficient, which describes the response of the *i-th* interviewee respecting to the importance attached by the decision-maker to the factor *k*, weighted at level *q*.

Since the dummy d_{mkq} = 1 for only one level of the factor *k*, $Ų_{ik}$ with reference to a profile *m* it corresponds to the usefulness of the same level for the factor *k*.

The total utility function $Ų_{it}$ of the i-th interviewed for a profile *m* of the service, in respect of all the *K* factors, is expressed in the following additive predictive model:

$$Ų_{it} = \sum_{k=1}^{K} \sum_{q=1}^{Q_k} W_{ikq} d_{mkq} + \varepsilon_{im} \qquad (8)$$

where:

- W_{ikq} - is the generic parameter "unknown" of *part-worths*;
- d_{mkq} - is the dummy variable;
- ε_{im} - is the relative profile *m* of the *i-th* interview error.

Similarly to the evaluation of partial utilities, the importance of the factors ranging between 0 and 1 is evaluated in a rational way of simplification determining the differential of its mode between the lower partial utility and the higher utility: i.e., its range of variation, summing the fields of variation of all factors and calculating for each factor the relationship between the range of variation and the sum of the ranges of variation.

To compute the relative importance of the factors that define Ψ we compare the partial utilities, obtaining values between 0 and 1 in accordance with the following steps (Menon & Sigurdsson, 2015):

- we calculate the variation range of the utility part of its mode;
- we add up the fields of variation of factors;
- for each factor, we calculate the ratio between the variation range and the sum of the variation ranges.

The partial utilities equation is, at the end:

$$\Psi_I = \frac{Ų_{itmax} - Ų_{itmin}}{\sum_{i=1}^{I} Ų_{itmax} - Ų_{itmin}} \qquad (9)$$

where:

l = 1,2,.. N [*N* = modal factors]

3.2.2. *The methodological CAIP design for parking*

First of all, to present the new methodological approach it is suggested to introduce the following taxonomy of needs: explicit, implicit and latent needs (Napolitano, 1999).

The explicit needs are the easiest to identify and correspond to the main functions performed by the service. Usually, the decision-maker explicitly asks for them (hence the name) and is satisfied, by definition, from all direct competitors. It should also take into account that the main functions required are not necessarily the same for different types of consumers-decision-makers (Shaw, Subramaniam, Tan, & Welge, 2001). For example, for the buyer of a stall for the unattended stopping, the explicit need could be given by the fact of avoiding the fine, but for another user could be given by the ease of parking.

The implicit needs are everything that the decision-maker gets for granted: if he gets it he does not take it into account, if they are missing he takes a strong perception of poor quality.

In fact, a big part of the needs related to products is implicit and their satisfaction is offered by all competitors. It is, for the market, a natural consequence of the fact that the characteristics of the service or additional services that prove to be commercially successful and they are readily copied by competitors.

The latent needs correspond to the characteristics of the offer which may be not fundamental, but which meet the needs that the decision-maker did not expect were satisfied. And therefore, for that matter, these needs are the difference between competitors with the offers on the similar basis. Any component of the offer may be a latent need: for example, in the case of parking, combined with a single ticket for the public transport parking (i.e. park and ride).

Then, it is supposed that the term "key” service means the provision required to meet the needs and desires of the decision-maker. Thus, for our CAIP design we consider the following general characteristics of key service:

- immateriality/intangibility;
- simultaneity/immediacy of consumption;
- the active participation of the decision-maker.

and the following general features:

- services work better in a system or network;
- production costs of the services are often indeterminable;
- services are not affected by neither assets nor inventories;
- prices of services are determined by opportunity costs or by the shadow prices;
- communication service characteristics complex is both in projective presentation and in the setting of the memory of the pilot services received;
- when the services present the difficulty of introduction of innovations;
- when the services standardize better the products, but almost never personalize the relationship between the decision-maker and the dispenser staff and so it becomes important the confidence in the general supplier of services;
- when the decision-maker is often a dispenser prisoner and enters in a situation of dependence of the Regulator.

The reference of these actions is always the decision-maker and "what he wants": what are his implicit, explicit and latent needs, i.e. the elements of evaluation and service evaluation ratio of the quality of service provided. For these reasons the qualitative, psychological (focus group) and quantitative (survey) inquiry, when activated, are very important for the decision-maker and they study:

- lifestyles;
- buying behaviour (such as explicit acts);
- reasons;
- needs;
- beliefs/prejudices;
- feelings/suggestions;
- expectations/projections;
- attitudes (such blunders)/attention;

for the information on aspects (complexes) of the services such as:

- identifying of the characteristics of the service;
- criteria for adoption and choice processes of the service;
- areas and factors of service quality;
- priorities of the specific service;
- profile picture of the Regulator when it is present;
- perceptions of the service by the decision-maker;
- levers for the loyalty of the decision-maker.

It is the phase finalized to correctly translate the needs and expectations of consumers-makers, detected in the phase of the expected quality, on target for the provision of service to be provided by developing and standardizing the characteristics of the delivery system of the service. The phase means the following settings (Vriens, 1994; Armstrong, Kotler, & He, 2000):

A. the analysis of the value of the service

B. the design of the system of service delivery such as:
- package of services;
- process, i.e. the preparation phase, the use and the after-service;
- elements of the delivery system of the service: relationships, continuous improvement.

It is the phase defined as the set of goods/physical performance and of intangible assets that transforms the set of tangible and intangible benefits in target and the performance-offers to the decision-maker and their relative prices/rates as:
- focusing on the needs/implicit expectations;
- focusing on the needs/explicit expectations;
- focusing on the needs/latent expectations.

The phase structure of service delivery consists of:
- preparatory requirements and the preliminary phase, i.e. the activities that require the interaction between the decision-maker and the front-office of the dispenser;
- time to use the service as a "moment of truth" (Normann, 1996; Testa, 2001);
- post-service as the management of the disservice and complaint, the constant contact with the decision-maker.

3.2.3. General enhancement of project design

Among the methods of exploitation of the needs the most commonly used are:
a) the enhancement with a 100 base score;
b) the enhancement with free score.

The enhancement with free score represents a simple and precise technique of subjective service evaluation ratio, but with an objectively acceptable focus group: to each of the needs of the segmented decision-maker is assigned a score of importance from the point of view of the decision-maker. That decision is made through a discussion on the merits and is not resolved by a vote (Corrao, 2005). In case of difficulty of decision for the choice of a value for a needy it recurs to the method of the choice cross, obtained by comparing the importance of the need with that of other respondents, and evaluating whether it is higher or lower and by how much.

The enhancement score with a base 100 score has the advantage of getting a balanced evaluation, even if in the absence of direct guidance of an expert to guide the focus group. It is the methodology used in the research of the market, where decision-makers are interviewed in critical situations that normally require the intervention of an expert in order to ensure the soundness of the construction and administration of the questionnaire. The questionnaire must be built by sharing all the needs of the decision-maker in areas that are homogeneous, one of each consists of some needs, such as the area of "product characteristics" (direct and indirect requirements related to the product), the area "service for the decision-maker" (direct and indirect needs related to the service), and so on.

In order to balance the needs of the decision maker we introduce the weighting scale - the scale of perception 0-9 of the value of the factor which is well represented in Table 1:

Table 1. Scoring for Perception.

Scoring	Perception
9	A Must
8	Very Important
7	Important
6	Reasonably Important
5	Important Medium
4	Important Modestly
3	Little Important
2	Very Little Important
1	Almost Irrelevant
0	Irrelevant

It is adopted the service evaluation ratio scale which is less immediately associated with the scholasticism (i.e. from 1 to 10, which does incur the underestimation - the so-called "to grade"), for example, from 0 to 9 (or from 1 to 5 as in Lickert scoring), and recalled, often, on the *focus group*, that the numbers are a summary of the scale of the qualitative service evaluation ratios of importance, from irrelevant and indispensable as a must (Dede, Kamalakis, & Sphicopoulos, 2015).

At the end of the evaluation of each segment, a check is carried out by calculating the average of the service evaluation ratios, excluding only those factors with a value equal to zero and the correspondence with the average value of the adopted rating scale by correcting the feedback until you reach the required average.

3.2.4. Analysis of the needs of the decision-maker or of the group buying the urban parking through the calculation of Θ ratio, A ratio and O ratio

Taking into consideration the users divided into homogeneous segments the primary and secondary needs are listed with the details, in direct and indirect (implicit, explicit and latent) correlated with the parking service, useful for the construction of a differentiation of the positioning, attractiveness and ability to compete. Thus, the constructed list is then enhanced by assigning a numerical value to every need according to what is important in the decision-maker's perception (Cohen, 2015).

By crossing the needs of the decision-maker it is possible to stipulate the characteristics of supply - service components. Such analysis identifies all the needs of the decision-maker to be satisfied with the parking offer, taking into account the importance of each need for the decision-maker, linking each need to the corresponding characteristics of each offer and bringing in the table also the characteristics of the offer with the control function.

Thus, in order to arrive to the final score to assign a relative importance and an evaluation to the experimental coefficient α at our multidimensional logit (equations 3, 5), which represents the offered level of service in the parking fitted area, it is suggested to estimate the supply – service components through introducing some additional coefficients (4).

The proposed *Θ ratio, A and O ratios* are calculated by filling in the tables of the "positioning" *Θ* of the parking lot, "attractiveness" A and "ability to compete" O (as in tables 6, 7 and 8 below). Our algorithm of the calculation is as it follows:

- to describe the critical success factors CSF in the appropriate fields (in the case of *Θ* ratio) or the factors of attractiveness fields (in the case of A ratio) and ability to compete in the appropriate fields (in the case of O ratio*)*;
- to assign a numerical relative importance to proportional distribution from 1 to 100 to the factors, taking into account that the sum of the relative importance factors must correspond to 100;
- to assign a qualitative value - converted into metric - in the score field (e.g. by performing the sum of the individual judgments, Delphi group, etc..) from 0 to 1.0 with reference to the service evaluation ratio scale;
- to multiply the relative importance for evaluation and, then, the relative importance for the score;
- to multiply in row and add in column.

4. Application of the new approach and results

4.1. A case study: the revision of the financial project of underground parking lot of Corrubbio Square in Verona (Veneto, Italy)

To reinforce the importance of our research we present the synthesis, at year 2005 and at year 2015 (revision) of the DCF (Discounted Cash Flow) analysis relative to the underground parking lot design "Corrubbio" in Verona (Fig. 1.), realized by the author in 2005, in which we confirm our hypothesis implemented in the equation 3, with the new coefficient α - formula 4, at discounted back cost.

4.2. Design phases and data collection

For the calculations carried out in the application of algorithmic to the underground parking lot Corrubbio Square we used the software SPSS 13.0 for CAIP and PHStat 2.5 dynamic add-in for Excel for Office 2003 for Crosstabs and calculations.

Fig. 1. Rendering and map of the realized underground parking lot of Corrubbio Square in Verona (Italy)

Data entry and project 2005 as below:

A. 2005 original design phase (with coefficient α_{2005} = 1)

- Data collection design: reduced design
  Data collection method with:
  - deterministic sequential hot deck type nearest-neighbour imputation;
  - data mainstreaming: NMAR;
  - statistical processing of missing data: MCAR;
  about:
  - free parking;
  - isochronous within 300 mt. from the centroid, accessible at the speed of 3 km/h in 6 minutes;
  - weekly stopping loading scenario;
  - weighted average parking cycle on the stall
  with:
  - systematic collection on the stalls at ground level;
  - non-probability sampling at reasoned choice;
  - data collection for days of the campaign: Thursday, Saturday, Sunday, seasoned in Autumn and for stake hours 10:00-13:00-20:00 (see Table 2. Scenario);
- Data collection method:
  - Calculation of the coefficient Ψ, as focus group modality for:
    - Two-way focus group;
    - Teleconference focus groups;
    - Way of the stimuli presented: verbal description;
    - Method of the presented stimuli: continuous rating scale;
  - Coefficient Θ method for stimuli evaluation: rating;
  - Coefficient A method for stimuli evaluation: rating;
  - Coefficient O method for stimuli evaluation: rating;
- Pay-off scenario:
  - Minimum minimorum;
  - Maximum maximorum;
  - Best estimate;
- Hypothesis for the economic-financial analysis (Table 2);
- Technical profitability design hypothesis (described in Table 3);
- Profitability hypothesis at 2005 (described in Table 4);

Table 2. Scenario and hypothesis for DCF analysis at 2005

Sampling days	Hypothesis of technical economic productivity	Use of parking road spaces	Stalls use formula
Thursday H 10	129	Non-residential	Pricing time
Thursday H 13	154	Mixed	Pricing time/ subscription
Thursday H 20	82	Residential	Saled
Saturday H 10	191	Mixed	Pricing time/ subscription
Saturday H 13	163	Mixed	Pricing time/ subscription
Sunday H 13	145	Residential	Subscription

Table 3. Technical profitability and load factor for the underground parking lot of Corrubbio Square in Verona (Italy) in design hypothesis at 2005

Parking stalls load factor[4]	Total design stalls = 302	% rate
Minimum minimorum	129 + 82 + (145 - 82) = 274 stalls	(274 / 302) % = 90.72 %
Maximum maximorum	145 + 154 = 299 stalls	(299 / 302) % = 99.00 %
Best estimate	82 + (145 – 82)+ 154 = 299 stalls	(299 / 302) % = 99.00 %

Table 4. Load factor for the underground parking lot of Corrubbio Square in Verona (Italy)

Equivalent stalls to occupy in minimum minimorum hypothesis	Management actions	Tariffs
129	Pricing time with increasing linear trend	€ 1.50 daytime € 0.52 nighttime for stall
63	Monthly subscription	€ 70 month for stall
82	Sale of the right of surface area for 30 years	€ 20,000 each

[4] In the minimum minimorum hypothesis such as in the best estimate one, the subtraction in parenthesis indicates the minimum residential parking potential volume, withdrawn from the potential residential peak stalls, with which it is feasible to go in subscription of the surface rights for 30 years.

- DCF (Discounted Cash Flow) analysis indexes (Brdulak & Zakrzewski, 2013) with English decimal mark (scenario 2005):
  - DCF start up at year 2005
  - Service life 30 years (+ 3 years for extension of the surface rights)
  - Start-up discount rate 2%
  - WACC 9.13%
  - DDM (Gordon model) 7.30%
  - Kd 4.66%
  - Ke 25.14%
  - CAPM 25.14%
  - Debt expiration years 30
  - Marginal Tax Rate 2005 33.00%
  - Debt capital at start up 3,360,000.00 €
  - Risk capital at start up 1,260,000.00 €
  - IRR adjusted 14.10%
  - NPV (Net Present Value) 1,087,355.30 €
  - ADSCR 1.37
  - TLLCR 0.80
  - PLCR (Project Life Cover Ratio) 0.69
  - Time Phasing 3 years

B. 2015 reviewed design phase (with coefficient $\alpha_{2015} \neq 1$)[5]**:**

For the re-calculations of the algorithmics for the underground parking lot in Corrubbio Square we now use the software IBM-SPSS 20 for CAIP and PHStat 3.0 dynamic add-in for Excel for Office 2011 for Crosstabs and calculations.The data entry and the project specifications are represented below:

- Calculation with CAIP of the coefficient Ψ in decimal notation: 0.84
- Data entry and project 2015
  Data collection design: reduced design
  Data collection method with:
  - deterministic sequential hot deck type nearest-neighbour imputation
  - data mainstreaming: NMAR
  - statistical processing of missing data: MCAR
- Data collection method 2015:
  - Calculation of the coefficient Ψ, as focus group modality for:
    - Two-way focus group
    - Teleconference focus groups
    - Way of the stimuli presented: verbal description
    - Method of the presented stimuli: continuous rating scale
  - Coefficient Θ method for stimuli evaluation: rating
  - Coefficient A method for stimuli evaluation: rating
  - Coefficient O method for stimuli evaluation: rating
- Pay-off scenario 2015
  - Minimum minimorum
  - Maximum maximorum
  - Best estimate
- Hypothesis for the economic-financial analysis (ibidem as in Table 2 for 2005)
- Positioning 2015 (The positioning for the underground parking lot of Corrubbio Square in Verona is represented below - Table 5);
- Attractiveness 2015 (The attractiveness for the underground parking lot of Corrubbio Square in Verona is represented below - Table 6);
- Ability to compete 2015 (The ability to compete for the underground parking lot of Corrubbio Square in Verona is represented below - Table 7);

Then, completing α experimental coefficient in formula (4):

$$\alpha = \left[\Psi_I * \Theta * \left(\frac{A+O}{2} \right) \right]^{-1} =$$

$$= \left[0.84 * 0.92 * \left(\frac{0.75+0.82}{2} \right) \right]^{-1} = 1/0.61$$

- Technical profitability design hypothesis 2015; The new load factor for the underground parking lot of Corrubbio Square in Verona is (Table 8).
- Technical profitability design hypothesis (described in Table 9).
- Profitability hypothesis at 2015 (as described in Table 10).

Thus, we offered in Table 10 the tariffs for urban parking which will permit to compete in the appropriate territory, basing our calculations on the

[5] The premise to be made for the revision of 2015, of the project implemented in 2005, is that the composition of the social classes in terms of interest, income and access has not radically changed in terms of lifestyle, buying behaviour, motivations and needs of parking consumer in the city of Verona (Veneto, Italy).

perceptual-behavioural approach with a non-parametric experimental coefficient for financial parking design. The 2015 scenario presented below demonstrates a negative variation of the parameters of the project's feasibility and bankability:

- DCF (Discounted Cash Flow) analysis indexes 2015, with English decimal mark:
  - DCF start up at year 2015 (using the 2005 data set)
  - Service life 30 years (+ 4 years for extension of the surface rights)
  - Start up discount rate 2%
  - WACC 9.13%
  - DDM (Gordon model) 7.30%
  - Kd 4.66%
  - Ke 25.14%
  - CAPM 25.14%
  - Debt expiration years 30
  - Marginal Tax Rate (at 2005) 33.00%
  - Debt capital at start up 3,360,000.00 €
  - Risk capital at start up 1,260,000.00 €
  - IRR adjusted << - 1.90%
  - NPV (Net Present Value) -3,050,717.79 €
  - ADSCR - 0.32
  - TLLCR - 0.62
  - PLCR (Project Life Cover Ratio) - 0.54
  - Time Phasing >> 30 years

Table 5. Positioning *Θ* for parking in decimal notation.

Evaluation criteria for	Parking competitor			Note:
Critical Success Factors	Relative importance [1]	Service evaluation [2]	Score [3] = [1] * [2]	Service evaluation [2] scale
Centrality	40	1.0	40.0	0,0 - 0,3 trash
Advanced equipment	5	1.0	5.0	
Great parking stalls	5	0.6	3.0	
Surveillance	10	0.8	8.0	0,31 - 0,6 poor
Easy payment	15	1.0	15.0	
Open 24 h	5	1.0	5.0	
City center proximity	10	1.0	10.0	0,61 - 0,8 good
Proximity to market and shops	10	0.6	6.0	
Total score per column	100	X	⇩	0,81 - 1,00 excellent
		Total score [3] = [1] * [2]		**92**	

Calculation of the coefficient Θ in decimal notation [3] / [1]: 0.92

Table 6. Attractiveness *A* of the target segment set

Evaluation criteria for	Market segment 1			Market segment ...n			
Market Attractiveness Factors	Relative importance [1]	Service evaluation [2]	Score [3] = [1] * [2]	Relative importance [1]	Service evaluation [2]	Score [3] = [1] * [2]	Total scores [4] of the target segment set
Individual disengagement	60	0.3	18.0	60	0.3	18.0	36.0
Disposable income	10	0.5	5.0	10	0.4	4.0	9.0
Protection day / night	20	0.5	10.0	20	0.5	10.0	20.0
Fines and constraints	10	0.5	5.0	10	0.5	5.0	10.0
Total score per column	100	X	⇩	100	X	⇩	⇩
	Total score [3] = [1] * [2]		**38.0**	Total score [3] = [1] * [2]		**37.0**	**75.0**

Calculation of the coefficient A in decimal notation [4] / [1]: 0.75

Table 7. Ability to compete *O* for target segment set

Evaluation criteria for	Market segment				Market segment ...n-1			Market segment ... n		
Ability to Compete Factors	Relative importance [1]	Service evaluation (expert) [2A]	Service evaluation (no expert) [2B]	Score [3] = [1] * [2A+2B]	Relative importance n-1 [1]	Service evaluation n-1 [2A + 2 B]	Score n-1 [3] = [1] * [2A+2B]	Relative importance n [1]	Service evaluation n [2A+2 B]	Score n [3] = [1] * [2A+2B]
Proximity with the centre	40.0	0.5	0.3	32.0						
Wide parking stalls	10.0	0.5	0.2	7.0						
Easy itinerary on foot	20.0	0.5	0.5	20.0						
Easy payment	5.0	0.5	0.3	4.0						
Fines and constraints	10.0	0.5	0.5	10.0						
Removal barriers	5.0	0.5	0.1	3.0						
Pooling service	10.0	0.5	0.1	6.0						
Total score per column	100	3.5	X		100	X		100	X	
	Total score [3] = [1] * [2A + 2B]			**82.0**	Total score [3] = [1] * [2A + 2B]			Total score [3] = [1] * [2A + 2B]		

Calculation of the coefficient *O* in decimal notation per each segment [3] / [1] : 0.82 and for total score of the segments the average value shall be calculated.

Table 8. Load factor for the underground parking lot of Corrubbio Square in Verona at 2015 (reviewed)

Sampling days	Hypothesis of technical economic productivity	Use of parking road spaces	Stalls use formula
Thursday H 10	23	Non-residential	Pricing time
Thursday H 13	154	Mixed	Pricing Time/ Subscription
Thursday H 20	82	Residential	Saled
Saturday H 10	191	Mixed	Pricing Time/ Subscription
Saturday H 13	163	Mixed	Pricing Time/ Subscription
Sunday H 13	145	Residential	Subscription

Table 9. Technical profitability and load factor for the underground parking lot of Corrubbio Square in Verona at 2015 (reviewed)

Parking stalls load factor	Total design stalls = 302	% rate
Minimum minimorum	23 + 82 + (145 - 82) = 168 stalls	(168 / 302) % = 55.62 %
Maximum maximorum	145 + 154 = 299 stalls	(299 / 302) % = 99.00 %
Best estimate	82 + (145 – 82)+ 154 = 299 stalls	(299 / 302) % = 99.00 %

Table 10. Load factor for the underground parking lot of Corrubbio Square in Verona (Italy)

Equivalent stalls to occupy in minimum minimorum hypothesis	Management actions	Tariffs
23	pricing time with increasing linear trend	€ 1.50 daytime € 0.52 nighttime for stall
63	monthly subscription	€ 70 month for stall
82	sale of the right of surface area for 30 years	€ 20,000 each

4.3. Results of the empirical application

The financial results presented in the DCF analysis 2015 - that reviews the DCF analysis of 2005 - show that the experimental coefficient α should correct heavily the value of time and the service level of MNL applied to the parking lot, because it intervenes radically on technical productivity of parking lot.

This results confirm a radical decrease in revenues that, in the period of useful life of the parking lot, prevents the realization of revenues sufficient for the construction of the parking itself.

Redoing the calculations of the revenues, using the same methods of 2003-2005 focusing in 2015, with stationary statistical data of the composition of the population of Verona, it shows that the car parking was not to build with those features.

The results of the current financial management of the Corrubio Square parking lot give us right.

This new computational method for estimating the experimental coefficient $\boldsymbol{\alpha}$ was adopted in 2015 for the calculation of economic and financial sustainability of another city's new underground car parking lot at the railway station of Verona (Italy).

5. Conclusions

The weak point of all economic and financial analysis is determined by the part relating to the benefits that the financial translation is attributable to revenues from the core business activities and income. For the determination of revenues, in the feasibility studies and financial plans the designers often use the hypotheses, assuming minimum reasonably desirable and sharing increases on most conceivable scenarios.

The financial plans required by law on public works, particularly in financial parking design as a project financing practise, often present deficits in computation, both in overestimation and in underestimation. This creates more difficulties for public administrators who have to decide interventions in public infrastructures in the light of the capital rationing and the spending review.

Thus, with the presented research we have shown how to introduce in the discrete choice model use the determination of the service level of the parking infrastructure and the appreciation of this level in relation with the value of time for targets.

We have instituted the behavioural parameters for the determination of the characteristics of the service level of the parking as well as of the service level perceived by potential consumers.

The present article demonstrates that a experimental parameter α, contained in multinomial logit equation - often overlooked by designers - is very important, individual and users needs predetermined for any design development if reported to the service level of any infrastructure.

Also we have shown how we can build an optimized multidimensional logit model as robust method to predict, with greater accuracy, the technical productivity and profitability of urban parking lot.

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