PROPOSAL FOR NEW METHOD OF EVALUATION OF ELECTRICAL INSTALLATION

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Abstract: This article describes the design of a new method of evaluation of electrical installations. Because the electrical installations are nowadays a lot of possibilities and options, it is necessary to evaluate the installation complex, from several perspectives and objectively. It is no longer possible to evaluate the electrical installations only by price or supplier. Due to the complexity of evaluation of electrical installation is a methodology that uses multi-criteria analysis - MCA.

Keywords: multicriteria analysis, MCA, electrical installation, evaluation

1. INTRODUCTION

Nowadays, when selecting electrical installation we proceed so that the individual characteristics of the installation are evaluated in sequence. The overall decision is then mostly due largely to its price, a manufacturer of components and variability. For this reason, it is clear that the overall assessment of an electrical installation is included subjective assessment of the assessor, so the overall rating may be biased and inaccurate. To be able to select the best electrical installation, you must use the appropriate method for the evaluation of the options from which to choose.

The multicriteria method is applied to individual options of electrical wiring, which were defined earlier, see Tab. 1. To encompassed in this method all the criteria according to which it would be possible to assess the installation option, it would be appropriate to prepare an independent scientific work or study dealing with the analysis based on a large set of the criteria established by experts or a group of designers who are dedicated to the design of both systems to intelligent and classical installation. It would be possible to pay attantion to a general set of smart installation, classical installation or set, where will be both of these variants of wiring so that it would be possible to choose the best option from the specified criteria. To describe a design of methodology for evaluation by the MCA these defined options will be enough, see. Tab. 1.

Functions	Option			
	A	B	C	D
Installation devices for switching and protection	o	o	o	o
Socket wiring				
Sockets for normal consumption	o	o	o	o
Sockets - Kitchen	o	o	o	o
Sockets with surge protection	o	o	o	o
Lighting control				
Lighting control switching	o	o	o	o
Lighting control dimming	-	-	o	o
Lighting control - PIR detectors	-	-	-	o
Link light on the twilight switch	-	-	-	o
Lighting scenes	-	-	-	o

Control of heating, air conditioning - AHU				
Conventional heating control thermostat	o	o	o	o
Heating control actuators Alpha 0-10V	-	-	o	o
AHU Performance Management	-	-	o	o
Monitoring of emergency conditions AHU	-	-	o	o
Management flue chimney	-	-	-	o
Control of underfloor heating according to MRC	-	-	-	o
Ventilation of bathrooms and toilets	o	o	o	o
Control of shutters, blinds				
Shutter control switch	o	o	o	o
Control of external blinds	-	-	o	o
Complete control of external shutters	-	-	-	o
Adjust of lugs	-	-	-	o
Security system, AV systems				
IA (Intruder Alarm)	o	o	o	o
FA (Fire Alarm)	o	o	o	o
Integrated IA	-	-	o	o
Integrated FA	-	-	o	o
TV	o	o	o	o
RF control				
Link to external panel EZS	-	-	-	o
Elect. lock the front door - RF	-	-	-	o
Control garage door - RF	-	-	-	o
User Interface				
Communication with the user via the GSM	-	-	o	o
Managing and monitoring the entire system - SCADA / HMI Reliance	-	-	-	o
Visualization - LCD Touch Panel	-	-	-	o
Software Win HomeServer	-	-	-	o

Tab. 1: Variants of electrical installation.

2. MULTICRITERIA ANALYSIS

Multi-criteria analysis (multi-criteria decision making) is selected as one of the options listed in that situation potentially viable options on the basis of large number of criteria.

In addition to formulating a list of indirect objective of the analysis is necessary to have a list of options from which the decision will be selected. This list can be specified explicitly, as a final list of options or implied terms of specifications, which must comply with the decision option that could be deemed admissible.

If there is available a list of decision criteria as well as a list of options, it is necessary to consider what form should have the final decision. Multi-criteria analysis basically is instrumental to simulation of decision-making situations in which is defined set of alternatives and group of criterions for evaluation of options. The general procedure involves the MCA at the level of resolution selected five relatively independent steps:

- A purpose-oriented set of evaluation criteria
- Establishment of evaluation criteria weights
- Determine the standard values of criteria weights
- Partial evaluation of options
- Choosing the best option or sorting options

2.1. QUANTITATIVE METHOD OF PAIRED COMPARISONS OF CRITERIA

This method uses the so-called Saaty matrix $S=(s_{ij})$, where i, j = 1,2 ,..., k where s_{ij} represent matrix elements, which are interpreted as estimates of the proportion of weights of the i-th and j-th criterion. The scale is determined by the values 1,2,3 ,..., 9 and the reciprocal values. The corresponding value of the verbal scale:

1 - equivalent to the criteria i and j
3 - slightly preferred the criterion i j
5 - strongly preferred the criterion i j
7 - strongly preferred the criterion i j
9 - absolutely preferred criterion i j

A value of 2, 4, 6, 8 represent intermediate steps. In our case, for simplification, the intermediate stage is unused.

For creation of Saaty matrix we define criteria f_1, f_2 ,..., f_k. Mutual comparison of these criteria, according to the above scale is created by a set of elements s_{ij} Saaty matrix $S=(s_{ij})$.

General registration Saaty matrix:

$$\begin{array}{c} \\ f_1 \\ f_2 \\ \vdots \\ f_k \end{array} \begin{array}{c} \begin{array}{cccc} f_1 & f_2 & \cdots & f_k \end{array} \\ \begin{bmatrix} 1 & s_{12} & \cdots & s_{1k} \\ 1/s_{12} & 1 & \cdots & s_{2k} \\ \vdots & & & \\ 1/s_{1k} & 1/s_{2k} & \cdots & 1 \end{bmatrix} \end{array} \qquad (1)$$

Saaty matrix defined for the analysis of the various wiring options. The sample is designed to create the basic criteria of the matrix and subsequent analysis.

	Acquisition costs	Operating costs	Saving energy	System maintenance	The possibility of heating	The possibility of lighting control	Reliability	Complexity of installation	Aesthetics
Acquisition costs	1	5	3	9	3	3	5	7	9
Operating costs	0,20	1	1	5	3	3	7	3	7
Saving energy	0,33	1,00	1	9	5	5	5	9	7
System maintenance	0,11	0,20	0,11	1	1	1	3	3	7
The possibility of heating	0,33	0,33	0,20	1,00	1	1	5	9	7
The possibility of lighting control	0,33	0,33	0,20	1,00	1,00	1	5	9	7
Reliability	0,20	0,14	0,20	0,33	0,20	0,20	1	9	9
Complexity of installation	0,14	0,33	0,11	0,33	0,11	0,11	0,11	1	5
Aesthetics	0,11	0,14	0,14	0,14	0,14	0,14	0,11	0,20	1

Tab. 2: Saaty matrix.

A simple way of determining the weights of the criteria entered from the matrix S consists in calculating the geometric mean of each row of the matrix.

$$g_i = \sqrt[k]{\prod_{j=1}^{k} s_{ij}};\ i, j = 1,2,...,k \tag{2}$$

Furthermore, the weights are normalized so that the following condition is fulfill

$$\sum_{i=1}^{k} v_i = 1; v_i \geq 0 \tag{3}$$

Standards can be related to

$$v_i = \frac{g_i}{\sum_{i=1}^{k} g_i};\ i, j = 1,2,...,k \tag{4}$$

The above defined Saaty matrices are computed the geometric mean of all lines of standardization and the weights of criteria:

Criterion	g_i	v_i
Acquisition costs	4,1718	0,303
Operating costs	2,2225	0,161
Saving energy	3,0615	0,222
System maintenance	0,8132	0,059
The possibility of heating	1,2414	0,090
The possibility of lighting control	1,2414	0,090
Reliability	0,5682	0,041
Complexity of installation	0,2842	0,021
Aesthetics	0,1741	0,013
Sum of weights of all criteria	-	1

Tab. 3: Table geometric diameters and weights of criteria.

After defining the weights of criteria should be followed in the analysis of determining the values of standard criteria. However for this is necessary preferably the group of experts as well as more extensive type of scientific work (eg dissertation work), which would be engaged only in problems of multi-criteria analysis for evaluation of individual options of wiring system. Therefore, in another part of this analysis indicated only a general guide.

Determination of standard values of the criteria

Defining of the set of sample values of the criteria usually associated with the term standard. Standard can be understood in two ways:

- detail the nature of the processed object - a model with which they are rated more options compared in order to obtain a copy of this object
- character building - a model solution, the properties are deliberately reduced to the essential properties of an object and these are compared in ratings

Partial evaluation of options

Evaluation whether an option under consideration meets certain way and to some extent, the desired objectives. The subject of evaluation is the degree of compliance with the objectives considered variants as individual criteria. There are several possible ways and methods to assess the resulting variations. The basic procedure for the partial evaluation is partial evaluation of alternatives and the synthesis of sub-evaluation of options in their overall evaluation.

Multicriteria evaluation methods

Most methods of multicriteria evaluation of options requires cardinal information about the relative importance of criteria that can be expressed using the vector weights of the criteria. The weights of

the criteria defined above using the paired comparison of quantitative criteria and subsequent lines of geometric mean. For more extensive processing of multi-criteria analysis of options would be appropriate wiring method as a weighted SUM - WSA.

2.2. METHOD WEIGHTED SUM-WSA

This method is based on the principle of utility maximization, but guilty of simplification that assumes only a linear utility function. First created standardized criterion-matrix $R=(r_{ij})$, whose elements are derived from different criteria matrix $Y=(y_{ij})$, using the transformation formula.

$$r_{ij} = \frac{Y_{ij} - D_j}{H_j - D_j} \tag{5}$$

In the previous formula, a linear transform criteria values so that $r_{ij} \in \langle 0,1 \rangle$, D_J criteria corresponding to the minimum value in column j a H_j corresponds to the maximum value of the criteria in column j. The pre-conditions is that the criterion to maximize the column j-col.

Criterion matrix $Y=(y_{ij})$. In this table correspond to columns and rows defined criteria ranked options. The matrix can be written as:

$$\begin{array}{c} \\ a_1 \\ a_2 \\ \vdots \\ a_k \end{array} \begin{array}{c} \begin{array}{cccc} f_1 & f_2 & \cdots & f_k \end{array} \\ \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1k} \\ y_{21} & y_{22} & \cdots & y_{2k} \\ \vdots & & & \\ y_{p1} & y_{p2} & \cdots & y_{pk} \end{bmatrix} \end{array} \tag{6}$$

When using an additive form of multi-criteria utility function is then equal to the option

$$u(a_i) = \sum_{j=1}^{k} v_j \cdot r_{ij} \tag{7}$$

The option, which reaches a maximum value of utility, ui is chosen as the best, or can be arranged based on their declining value of the benefits.

3. CONCLUSIONS

This paper is focused to problems of use of sophisticated methods for selecting wiring not only technical solution based on the price, but also basis of many other criteria such as comfort, service, life, etc. The theme reflects the recent rapid developments in the system wiring, control technology but also communications equipment. The focus of work should be discussion of wiring systems from a global perspective, where the objective evaluation and selection of appropriate system wiring is no longer possible to common approaches, given the magnitude of such systems and their mutual ties. It offers the use of some of the methods of multi-criterial analysis (MCA), which affected extensiveness solution. The result of the work should be software design for evaluation of technical solutions to wiring, which would also include the functions of feedback on the effectiveness of solutions, utility value, price, etc., which would also serve as a knowledge base.

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