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Research Article

Evaluation of the relevance of LED lamp selection based on manufacturer-declared parameters

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Abstract—**The purpose of this study was to evaluate the relevancy of LED lamp parameters to ordinary customers as well as to find out which parameters are more or less significant for the purchasers. It was found that the majority of customers have some difficulties understanding the luminous parameters of LED lamps but are aware of the efficiency and advantages of these artificial light sources. In order to propose the selection guide for LED lamps, the MCDM (Multiple-Criteria Decision-Making) techniques were applied. The proposed algorithm consists of eight steps and covers all LED lamp parameters declared by the manufacturer.**

Index Terms—**Artificial Light Sources, Efficiency, LED lamps, Luminous parameters, Multiple-Criteria-Decision-Making.**

I. Introduction

In the modern world, light-emitting diode (LED) lamps are actively used to illuminate domestic and industrial premises and are confidently replacing other types of lamps, such as halogen, luminescent and incandescent lamps. By 2026, the LED lamps market is expected to grow by 211 percent compared to 2020, when LED lamp production reached US$75.8 billion [1]. The high growth of LED bulb production is based on the cogent advantages of its luminous and electric parameters in comparison to other types of lamps [2]. The main parameters such as rated power (P), efficiency (η), luminous flux (Φ), and life-time (LT) of four light bulbs commonly used in home applications are presented in Table 1.

As can be seen from Table 1, LED lamps provide the highest quality artificial lighting and are more economical than other types of lamps using different physics to produce the light.

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TABLE I
THE COMPARATIVE PARAMETERS OF GENERALLY USED LIGHT BULBS

	Incandescent lamp	Halogen lamp	Luminescent lamp	LED lamp
Life time, T, houres	1000	2000	8000-20000	> 50 000
Efficiency η, lm/W	10	30	60	≈95
Average luminous flux, Φ, lm	Power, W			
400	40	30	9	4
650	60	40	12	5
900	75	52	15	8
1200	100	67	20	10
1600	150	87	23	15

Approximately 3.5 times longer than luminescent lights, 25 times longer than halogen lamps, and 50 times longer than incandescent bulbs is the lifespan of an LED lamps.

The amount of luminous flux depends on the amount of power consumed. The more power an artificial light source uses, the more luminous flux is produced. In this rating, both LED and luminescent lamps show satisfaction results, although the LED lamp's consumption of electric power for producing the same amount of luminous flux is around twice as low. The low and worst results of this parameter are demonstrated by halogen and incandescent lamps accordingly. A halogen lamp requires 78 watts to produce a luminous flux of 1600 lumens, while an incandescent bulb consumes twice as much energy.

Another important indicator is the efficiency of the artificial light source. The efficiency of the incandescent lamp is the lowest, while the values of the luminescent, halogen, and LED light sources are 60 percent, 30 percent, and 95 percent, respectively. The efficiency of an artificial light source is defined [3] as the ratio of the light flux produced by this source to the electrical power consumed from the electric grid and expressed in lm/W. Due to the development of semiconductor technology and materials science, the efficiency of LED light sources is approximately doubling every three years [4]. According to EU regulation [3], the light bulb efficiency should not be less than 85 lm/W.

Nowadays, the prices for electricity in Lithuania for residential consumers are on average 0.24 Eur./kW [5].

According to Eurostat report [8], the amount of electricity consumed by the average consumer for lighting is 9 to 12 % of total consumption. Therefore, it is preferable and advised to utilize LED lighting. As the recommended standard efficacy for other types of lamps presented in Table 1 is below 85 lm/W, only LED artificial light sources will be addressed in this article.

However, the LED bulbs proposed by manufacturers have different numerical values for the same parameters, such as life span, efficiency, and luminous flux, and thus it is important to find out how and on what basis ordinary buyers choose a certain light source.

In these latter days, there are a sufficient number of studies dealing with lamp-choosing aspects for domestic usage. The study [6] shows that the main motives for using LED lamps are price, quality, energy savings and consumption, reliability of LED lamps, compatibility of LED lamps with lighting fixtures, brand, product availability, and environmental friendliness. Three key factors led researchers to select LEDs: increased lamp life, reduced energy use, and lower utility costs [7]. According to the study [8], 34% of respondents are extremely well knowledgeable on the benefits of LEDs, 60% are just somewhat informed, and 6% hardly know anything. This study also asserts that three factors—brightness, low energy consumption, and durability—have an effect on the selection of LED lamps. However, which parameters play a decisive role when choosing a light source or in what order these parameters are evaluated by purchasers is not specified. Moreover, there is not enough research to clarify the choice of lamp based on the parameters specified by the manufacturer.

In order to specify how ordinary customers are aware of the parameters of the LEDs indicated on the package, a survey was conducted in the home-use store. 1115 people were interviewed during the survey. The questions and answers are from the interview presented in Table 2.

TABLE II
QUESTIONNARIE RESULTS ABOUT AWARENESS OF THE LED LAMP PARAMETERS

Questions	Answers			
	Yes	No	Fragmentarily	Unaware
Do you know which parameters of a light bulb you should pay attention to before buying it?	28%	33%	29%	10%
Do you understand the physical parameters of the LEDs indicated on the package?	16%	18%	59%	7%
Are you aware of which parameters must be shown on the bulb light package?	30%	55%	14%	6%
Do you use internet sources to ensure the right choice of lamp?	57%	13%	27%	3%

The review results in Table 2 demonstrate that 72% of respondents found it difficult to identify the primary lamp specifications, and 84% of consumers did not clearly comprehend what the parameters of lamps meant. Seventy percent of the participants lacked precise knowledge of the requirements for the manufacturer's label on the package of light bulbs. Also still, the majority of respondents (57%) research lightbulbs online before making a purchase. But the internet can't always provide accurate information regarding lamp parameters, so everyone should be cautious and make sure the sources they rely on are reliable [9]. Consumers who are looking for precise information regarding lamp parameters should make use of reliable websites, manufacturer specifications, and articles that have undergone expert review [10].

The purpose of this study is to evaluate the importance of the LED bulb parameters declared by the manufacturers and to determine which lamp's specified parameters and in which sequence are more or less preferred when choosing an affordable artificial light source using MCDM (Multiple-Criteria Decision-Making) techniques.

II. THE PARAMETERS OF LIGHT BULBS DECLARED BY MANUFACTURERS

The information designated on the lamp's package should comply with the regulation [3]. Manufacturers often include information about a lamp that falls into one of two categories on the package. One of these is the lamp's electrical specifications, including the rated voltage (U, V), wattage (P, W), and grid frequency (f, Hz) to which it can be connected.

The luminous parameters of a lamp are a different set of parameters [11]. These comprise a lamp luminous flux (Φ), the light source's lifetime (LT), color temperature (TC), color rendering index (CRI), and light beam angle (LBA). A list of LEDs lamp from one of the stores is shown in Table 2. Lamps from the same manufacturer are identified by the same capital letter, and that companies' product line is identified by a numerical index. The Table 3 displays the rated specifications for each artificial light source that the customer may see on the package.

Rated power (P, W). The amount of energy consumed by the lamp to produce light is indicated by its rated power.

Visible light is a small part of the spectrum of electromagnetic radiation in the range from 360 to 830 nm that causes a visual sensation in the human eye. The amount of visible light emitted by a lamp is called the *luminous flux (Φ)*. This parameter is measured in lumens (lm) and is related to the power of the lamp, but, as can be seen from Table 2, it does not have a linear relationship with the rated power of a lamp.

The *efficiency* of a lamp is its most crucial component. Efficiency is defined as the luminous flux (Φ) to lamp power (P) consumption ratio.

Also, manufacturers indicate the energy efficiency class (EEC) of the lamp. *The EEC* label provides details about an electrical appliance's energy usage so that customers may choose the best model of lamp. This is underlined on the label by the use of colors on the arrows, where green denotes maximum efficiency and red denotes the lowest performance level. For the lamps, the energy efficiency classes are separated into seven categories, with values stated as letters from A to G and indicating the efficiency range of artificial light sources [12]. The efficiency of Class A lights is 210 lm/W. The ranges of 185-210, 160-185, 135-160, 110-135, and 85-110 lm/W, respectively, show the efficacy of artificial light sources with classes B, C, D, E, and F. The class G lamp has the lowest efficiency, which is 85 lm/W.

Colour temperature (TC) describes the tone of the light that a light bulb emits. Between 1000- and 10,000-degrees Kelvin are used to quantify TC. It is very important that customers select a lamp with the proper colour temperature when lighting a space. The TC has a significant impact on the human psyche because different colours of light induce different feelings, moods, and associations. The lighting manufacturers use a variety of colours to make the light that is emitted look pleasing to the eye [13]. The impact of light's colour temperature on a person's physical and mental health can be either beneficial or harmful. A light that is between 2300 and 3000 K in temperature is better for the eyes and more relaxing. According to research [14], exposure to light with a TC of 5000–6000 K elevates blood pressure, heart rate, and levels of both physical and mental activity. To avoid health case deterioration, it is recommended to reside in a high-TC environment for no more than 3-5 hours per day. The TC range of artificial light sources within 2200–3000K is best for human vision.

Another important characteristic of a lamp is the *colour rendering index (CRI).* The CRI is a luminous parameter of an artificial light source that indicates how accurately that light source displays the natural colours of the illuminated object [15]. The CRI range is defined from 0 to 100. If CRI is 0, then all objects have the same colour. If the CRI is 100, then the light source transfers to the observer the true colours of the object. The low CRI that cannot simulate day-light colours decreases serotonin production in the human brain and causes serotonin syndrome. The higher the CRI of the artificial light source, the better the colour rendering. A study [16] shows that for the avoidance of vision problems, it is recommended to use luminaries with sufficient colour rendering of at least 80.

The spread of light from the light source is defined as the *light beam angle (LBA)* and measured in degrees. LBA determines the area illuminated by the light: with a higher LBA, more area is illuminated, and with a lower LBA, a smaller area is lightened [17]. The light will be more evenly dispersed but will have less luminous flux with wider beam angles. Conversely, greater light intensity will distribute less light at narrower angles.

TABLE III
LED LAMP' PARAMETERS DECLARED BY MANUFACTURES

Code/index	Rated Power P, W	Luminous Flux Φ,lm	T_{C}, K	Light Beam Angle LBA, ⁰	Energy Efficiency Class EEC			Price, Eur	Lifetime LT, years	CRI
					Letter	Efficiency η lm/W	Average Efficiency η_{av} lm/W			
A1	7,5	806	2700	360	D	135-160	147,5	10,99	1,7	95
A2	4	470	4000	360	E	110-135	122,5	5,99	1,7	80
A3	6,5	806	2700	360	E	110-135	122,5	6,49	1,7	80
B1	5,9	806	2700	360	D	135-160	147,5	9,29	1,7	90
B2	8	806	2700	360	F	85-110	97,5	4,79	1,7	80
B3	10,5	1521	2700	150	D	135-160	147,5	12,99	1,7	90
B4	8,5	1055	4000	150	E	110-135	122,5	9,79	1,7	80
B5	12,5	1521	2700	150	E	110-135	122,5	8,79	1,7	80
B6	10	1055	2700	150	F	85-110	97,5	5,79	1,7	90
B7	7,5	806	4000	150	F	85-110	97,5	4,79	1,7	80
C1	8,8	806	4000	360	F	85-110	97,5	4,79	10	80
C2	11	1060	4000	360	F	85-110	97,5	5,79	10	80
C3	13,2	1521	4000	360	F	85-110	97,5	8,79	10	80
D1	10	1065	4000	220	F	85-110	97,5	4,79	2,85	85
D2	13,5	1521	6400	220	E	110-135	122,5	6,99	2,85	85
D3	10	1055	3000	220	E	110-135	122,5	6,99	2,85	85
D4	10	860	3000	200	E	110-135	122,5	3,29	2,85	85
D5	12	960	3000	240	E	110-135	122,5	3,79	2,85	85
D6	12	1060	3000	240	E	110-135	122,5	8,99	2,85	85
D7	15	1340	2700	360	A	210	210	5,49	2,85	85
D8	18	1901	6400	360	A	210	210	6,49	1,7	85
D9	15	1500	6400	360	A	210	210	5,49	1,7	85
D10	15	1350	4000	360	E	110-135	122,5	5,49	1,7	85
D11	18	1900	3000	120	A	210	210	6,49	2,3	85
D12	15	1340	3000	360	A	210	210	6,49	1,7	85

The room should be evenly and brightly illuminated throughout by the LB with an LBS of 360 degrees. The narrow LBA light bulb (from 10 to 46 degrees) emits light that only illuminates the designated region of the room. The lamps, presented in the Table 2 are classified [18] as having wide (100-1300) and very wide (1300 or more degree) LBA. LBs with a narrow LBA are used for the illumination of working places. If there are several working places in the room, the number of LB with narrow LBA should be increased in accordance with the number of working places. For ordinary areas, it is preferable to use artificial light sources with a wide LBA that help to decrease their amount as well as save electric energy consumption.

III. MATHEMATICAL MODEL FOR THE LIGHT SOURCE SELECTION

In order to determine the level of importance of lamp parameters that influence choice and to propose the selection algorithm for LED lamps, the Multiple-Criteria Decision-Making (MCDM) technique was used. The MCDM method was applied to the lamps, whose parameters are presented in Table 3.

The MCDM clearly assesses numerous competing factors in decision-making. The equations used in this section were published in [19]. Using the MCDM method, a *n x m* working table is created in which the first column, in the form of an *X* quantity, contains alternatives that can affect the final decision. For this study, quantity *X* is the number of LED lamps offered by the store (Table 3).

$$X = \{x_i\}, \quad i = 1, n; \; n = |X| \tag{1}$$

Here: *X*-is the quantity of proposed lamps;
n - the number of proposed lamps.

The quantity R represents the criteria for lamps that are written in the first row of Table 4 and includes price (Pr), average efficiency (η_{av}), rated power (P), luminous flux (Φ), colour temperature (T_C), colour rendering factor (CRI), light beam angle (LBA), and lifetime (LT). The listed criteria are arranged in order from the most significant to the least significant. The significance of criteria was determined according to interview results (Table 2) and based on the studies [6-8].

$$R = \{r_j\}, \quad j = 1, m; \; m = |R| \tag{2}$$

Here: *R*-is the quantity of proposed criteria;
m - the total number of proposed criteria.

Therefore, the working table should consist of *n* rows and *m* columns.

At the next stage of the analysis, the weight of each criterion is calculated. As the number of criteria *m* is less than [20] for the weight determination, the simplified equation (3) is used:

$$\omega_j = \frac{2 \cdot (m - j + 1)}{m \cdot (m + 1)} \tag{3}$$

Here: ω_j-is the weight of j criterion.

If all the criteria for the customer are equivalent, that is, he cannot decide which of the criteria is greater or less important for him, then the weights of all criteria are calculated as follows:

$$\omega_j = \frac{1}{m} \tag{4}$$

For both weighted or equivalent criterion case, the correctness of the criteria weight calculation is checked by accepting that the sum of all weights must be equal to one:

$$\sum_{j=1}^{m} \omega_r = 1 \tag{5}$$

The following phase of the analysis includes the calculations of the values of the local priority vector (LPV) using one of the formulas (6) or (7). The LPV quantitatively describes the set of features, i.e., a set of criteria inherent in one object, i.e., an alternative. The calculated NPV values u_{ij} are entered in Table 4 through the slash. The choice of formula (6) or (7) is carried out according to the rule: a) if an increase in indicators among alternatives according to one or another criterion leads to an improvement in quality, formula (6) should be used; b) if the increase in indicators among alternatives for one or another criterion leads to a deterioration in quality, formula (7) is used:

$$u_{ij} = \frac{c_{ij} - c_{ij}^{min}}{c_{ij}^{max} - c_{ij}^{min}} \cdot 100\% \tag{6}$$

$$u_{ij} = \frac{c_{ij}^{max} - c_{ij}}{c_{ij}^{max} - c_{ij}^{min}} \cdot 100\% \tag{7}$$

Here: u_{ij}-is LPV defined for the u_{ij} element of Table 3, %;
c_{ij}-the weighted value *j* criterion of the alternative *i*;
c_{ij}^{max} and c_{ij}^{min} is a maximum and minimum values of weighted criterion *j*.

Finally, the vector of global priorities (VGP) is obtained. The VGP is the ultimate goal of multi-criteria analysis and determines the only possible solution from the total set of proposed alternatives. The values of the GPV are defined as *V={vi}, i=1, n* and calculated using equation (8):

$$v_i = \sum_{j=1}^{m} u_{ij} \cdot \omega_i \tag{8}$$

Here: ω_i-is the weight of *i* alternative.

The determination of the optimal value of VGP with the designation of the number of the optimal alternative, that is, the desirable solution of selection, is carried out using a set of expressions (9):

$$v_{opt} = \max\{v_i\}; \quad i_{opt} = k; \; x_{opt} = x_k \tag{9}$$

Here: v_{opt}-is optimal value of VGP;
k-is the number of optimal alternatives.

IV. MODELLING RESULTS AND DISCUSSIONS

Table 4 presents the results of selecting a single artificial light source from a set of 25 LED lamps according to the parameters declared by the manufacturers. Bold blue and red mark the lowest and highest values of the criteria within one alternative, as well as the values of the LPV in points. LPV criteria Pr., P, and TC were calculated using equation (7), that is, guided by the principle that the greater the value of the criterion, the worse for the purchaser. For all other criteria, namely η, Φ, CRI, LBA, and LT, equation (6) was applied, since the higher the value of the criterion, the better this product is for the customer. The value of LPV is written with a slash and, in some cases, has values equal to either 0 or 100 points. 0 points for an alternative under the condition "the more the better" and 100 points for the condition "the more the worse" mean that the criterion of this alternative has the lowest possible value within the range of one criterion. Conversely, a score of 0 for the "the more the worse" alternative and a score of 100 for the "the more the better" alternative indicates the highest declared value of the criterion.

As a result of calculations, it has been defined that when applying criteria weighted by priorities (the weight of each individual criterion differs from the weights of all other criteria) and equivalent criteria weights, the selection result is the same.

This is an alternative x20 with an alphanumeric code of D7. In the category of criteria "the more, the worse," alternative D7 has a price equal to 5.49 euros, which is 1.4 times more than the designated minimum of 3.29 euros. The TC parameter is equal to the minimum value of 2700K, and the rated power is 3.75 times greater than the minimum. As mentioned earlier, the amount of luminous flux Φ depends on the power P, so to achieve a luminous flux of 1340 lm, which is only 1.4 times less than the designated maximum value of 1901 lm, this amount of energy is adequate. It should also be noted that the alternative D7 has an efficiency class of A, that is, the highest of all the proposed. Therefore, practically all electrical energy will be converted to light. The luminous flux Φ criterion belongs to the category "the more, the better." In the "the more, the better" category, the LBA parameter is equal to the maximum possible of 360 degrees, while the life-time LT of the D7 alternative is 2.85 years, which is significantly less than the maximum of 10 years. However, it should be noticed that the lamp's LT is primarily dependent on the number, frequency, and duration of its switching cycles. Therefore, the low value of this criteria obtained as a result of the simulation should not confuse the purchasers. The CRI parameter has an average of 85 units, which is quite high for the narrow range of this alternative, from 95 to 80.

TABLE IV
MCDM ANALYSIS' RESULTS

Alternatives $X=\{x_i\}, i=1, n=25$			Criteria $R=\{r_j\}, j=1, m=8$								VGP[1]	VGP[2]
			j_1	j_2	j_3	j_4	j_5	j_6	j_7	j_8		
			Pr, Eur	η_{av}	P, W	Φ, lm	T_C, K	CRI	LBA, ⁰	LT, years		
			ω_1	ω_2	ω_3	ω_4	ω_5	ω_6	ω_7	ω_8		
i	x_i	Code/ index	0,222/ 0,125	0,194/ 0,125	0,167/ 0,125	0,139/ 0,125	0,111/ 0,125	0,083/ 0,125	0,056/ 0,125	0,028/ 0,125		
1	x_1	A_1	10,99/20,6	147,5/44,4	7,5/75,0	806/23,5	2700/100,0	95/100,0	360/100,0	1,7/0,0	54	58
2	x_2	A_2	5,99/72,2	122,5/22,2	4/100,0	470/0,0	4000/64,9	80/0,0	360/100,0	1,7/0,0	50	45
3	x_3	A_3	6,49/67,0	122,5/22,2	6,5/82,1	806/23,5	2700/100,0	80/0,0	360/100,0	1,7/0,0	53	49
4	x_4	B_1	9,29/38,1	147,5/44,4	5,9/86,4	806/23,5	2700/100,0	90/66,7	360/100,0	1,7/0,0	57	57
5	x_5	B_2	4,79/84,5	97,5/0,0	8/71,4	806/23,5	2700/100,0	80/0,0	360/100,0	1,7/0,0	51	47
6	x_6	B_3	12,99/0,0	147,5/44,4	10,5/53,6	1521/73,4	2700/100,0	90/66,7	150/12,5	1,7/0,0	45	44
7	x_7	B_4	9,79/33,0	122,5/22,2	8,5/67,9	1055/40,9	4000/64,9	80/0,0	150/12,5	1,7/0,0	37	30
8	x_8	B_5	8,79/43,3	122,5/22,2	12,5/39,3	1521/73,4	2700/100,0	80/0,0	150/12,5	1,7/0,0	42	36
9	x_9	B_6	5,79/74,2	97,5/0,00	10/57,1	1055/40,9	2700/100,0	90/66,7	150/12,5	1,7/0,0	49	44
10	x_{10}	B_7	4,79/84,5	97,5/0,00	7,5/75,0	806/23,5	4000/64,9	80/0,0	150/12,5	1,7/0,0	42	33
11	x_{11}	C_1	4,79/84,5	97,5/0,00	8,8/65,7	806/23,5	4000/64,9	80/0,0	360/100,0	10/100,0	49	55
12	x_{12}	C_2	5,79/74,2	97,5/0,00	11/50,0	1060/41,2	4000/64,9	80/0,0	360/100,0	10/100,0	46	54
13	x_{13}	C_3	8,79/43,3	97,5/0,00	13,2/34,3	1521/73,4	4000/64,9	80/0,0	360/100,0	10/100,0	41	52
14	x_{14}	D_1	4,79/84,5	97,5/0,00	10/57,1	1065/41,6	4000/64,9	85/33,3	220/41,7	2,85/13,9	47	42
15	x_{15}	D_2	6,99/61,9	122,5/22,2	13,5/32,1	1521/73,4	6400/0,0	85/33,3	220/41,7	2,85/13,9	39	35
16	x_{16}	D_3	6,99/61,9	122,5/22,2	10/57,1	1055/40,9	3000/91,9	85/33,3	220/41,7	2,85/13,9	49	45
17	x_{17}	D_4	3,29/100	122,5/22,2	10/57,1	860/27,3	3000/91,9	85/33,3	200/33,3	2,85/13,9	55	47
18	x_{18}	D_5	3,79/94,8	122,5/22,2	12/42,9	960/34,2	3000/91,9	85/33,3	240/50,0	2,85/13,9	53	48
19	x_{19}	D_6	8,99/41,2	122,5/22,2	12/42,9	1060/41,2	3000/91,9	85/33,3	240/50,0	2,85/13,9	43	42
20	x_{20}	D_7	5,49/77,3	210/100,0	15/21,4	1340/60,8	2700/100,0	85/33,3	360/100,0	2,85/13,9	68	63
21	x_{21}	D_8	6,49/67,0	210/100,0	18/0,0	1901/100,0	6400/0,0	85/33,3	360/100,0	1,7/0,0	57	50
22	x_{22}	D_9	5,49/77,3	210/100,0	15/21,4	1500/72,0	6400/0,0	85/33,3	360/100,0	1,7/0,0	59	51
23	x_{23}	D_{10}	5,49/77,3	122,5/22,2	15/21,4	1350/61,5	4000/64,9	85/33,3	360/100,0	1,7/0,0	49	48
24	x_{24}	D_{11}	6,49/67,0	210/100,0	18/0,0	1900/99,9	3000/91,9	85/33,3	120/0,00	2,3/7,2	61	50
25	x_{25}	D_{12}	6,49/67,0	210/100,0	15/21,4	1340/60,8	3000/91,9	85/33,3	360/100,0	1,7/0,0	65	59

VGP[1]- is the vector of global priorities under weighted criteria
VGP[2]- is the vector of global priorities under equilibrium criteria

IV. Conclusion and Recommendation

During the study, it was found that selecting an appropriate LED lamp for residential use becomes challenging because most consumers lack a thorough awareness of factors like the luminous qualities of artificial light sources. The majority of respondents make a choice, paying attention to price, wattages, and efficiency, while other luminous parameters of lamps declared by manufacturers are little known or unknown at all. The CRI, Φ, TC, and LBA are complicated concepts for many common customers, despite the fact that they have a direct impact on how an illuminated item is physically perceived by the human eye. In order to optimize the possible options from the set of proposals, a mathematical model of "Multiple-Criteria Decision-Making " analysis was proposed. The MCDM method allows one to select one lamp with optimal parameters from the proposed N items and identify parameters that are questionable or do not have a significant impact on the final choice, such as power rating P, CRI, and LT. It is reasonable to consider the energy efficiency class (EEC) at the beginning of the selection process. In the second step, it is useful to determine the desired power (P) and luminous flux (Φ) of the light bulb.

Additionally, because the CRI parameter for LED lamps has a fairly limited range from 80 to 95, it is not essential to specifically regard one because it should be equal to or greater than 80. Another parameter that should not be taken into consideration is the lifetime (LT) of the lamp because, as mentioned above, it depends on the frequency of the lamp's commutation.

Summarizing the study, the authors propose an LED lamp selection algorithm in several steps. This LED lamp selection guide is offered according to the above conclusions, covers all the criteria involved in modelling, and includes the following steps:

1. Determine an admissible price.
2. Make sure that the electrical efficiency class is in the range [A; C].
3. Review the rated power; it should be as low as possible.
4. Check the luminous flux: it should be no less than 806 lm.
5. Make sure the color temperature does not exceed 4000K.
6. Verify that the CRI is not less than 80.
7. Review the light beam angle: it should be higher than 240 degrees.
8. Examine the lifetime: the bigger the number of hours, the better.

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