Analysis of Electronic Business of European Union and Serbia Companies Based on the LMAW-DNMA Method

Radojko LUKIC
Faculty of Economics University of Belgrade
radojko.lukic@ekof.bg.ac.rs

Modern companies perform their business activities in the classic way and electronically. Recently, there is an increasingly pronounced trend for companies from all countries of the world, which means both the European Union and Serbia, to conduct business activities electronically. Electronic business enables the performance of business activities in real time, without geographical and time barriers. The effects of electronic business are, among other things, an increase in sales, a reduction in costs and thus an increase in profits. In this paper, the trend and rankings of the electronic business of companies in the European Union and Serbia are comparatively analyzed. The general conclusion is that the participation of electronic business in the overall business of companies in the European Union and Serbia is increasing. This is almost the case with companies all over the world. The electronic business of Serbian companies is at a lower level compared to companies in the European Union. It is also at a lower level compared to companies in Croatia and Slovenia. Considering the positive effects of electronic business, it is necessary for Serbian companies to invest as much as possible in information and communication technology.
Keywords: *Website, Use of Enterprise Resource Planning (ERP), Use of Customer Relationship Management (CRM), enterprise, European Union, Serbia, LMAW-DNMA method*
DOI: 10.24818/issn14531305/27.3.2023.03

1 Introduction

Companies today perform their business activities in the classic way and electronically. Research on the development of electronic business of all companies is very challenging, current, important and complex [1-10], [14-20]. Statistics record the trend of increasing electronic business in the total business of companies in all countries of the world, which means the European Union and Serbia [10-13]. This is completely understandable when you consider the fact that business activities can be carried out in real time, without time and geographical barriers. The effects of this are, among other things, an increase in sales, a reduction in costs and thus an increase in profits. It should be emphasized that in the conditions of the Covid-19 corona virus pandemic, the importance of developing and performing, in addition to traditional business, electronic business has come to the fore.

In this paper, starting from the actuality and importance, on the basis of statistical data of Eurostat, the reached level of development and ranking of the electronic business of the companies of the European Union and Serbia is comparatively analyzed. In addition to the classic methodology, the LMAW-DNMA method is used. The LMAW-DNMA method, as a multi-criteria decision-making method, enables the selection and ranking of companies from the European Union and Serbia based on a number of criteria according to the development of electronic business. Based on that, the current situation and the need for the development of the company's electronic business in order to achieve the target performance can be realistically assessed.

2 Research methodology

The research methodology of the treated problem in this paper is based on the classical methodology and, in particular, on the application of the LMAW-DNMA method [4], [5], [9], [14].

The LMAW (Logarithm Methodology of Additive Weights) method is the latest method used to calculate criteria weights and rank

alternatives [9[, [4]. It takes place through the following steps : m alternatives $A = \{A_1, A_2, \dots, A_m\}$are evaluated in comparison with n criteria $C = \{C_1, C_2, \dots, C_n\}$with the participation of k experts $E = \{E_1, E_2, \dots, E_k\}$and according to a predefined linguistic scale [14].

Step 1: Determination of weight coefficients of criteria

Experts $E = \{E_1, E_2, \dots, E_k\}$set priorities with criteria $C = \{C_1, C_2, \dots, C_n\}$in relation to previously defined values of the linguistic scale. At the same time, they assign a higher value to the criterion of greater importance and a lower value to the criterion of less importance on the linguistic scale. By the way, the priority vector is obtained. The label γ_{cn}^{e}represents the value of the linguistic scale that the expert $e(1 \le e \le k)$assigns to the criterion $C_t(1 \le t \le n)$.

Step 1.1: Defining the absolute anti-ideal pointγ_{AIP}

The absolute ideal point should be less than the smallest value in the priority vector. It is calculated according to the equation:

$$\gamma_{AIP} = \frac{\gamma_{min}^{e}}{S}$$

where is $\gamma_{min}^{e}$the minimum value of the priority vector and *S* should be greater than the base logarithmic function. In the case of using the function Ln, the value of *S* can be chosen as 3.

Step 1.2: Determining the relationship between the priority vector and the absolute anti-ideal point

The relationship between the priority vector and the absolute anti-ideal point is calculated using the following equation:

$$n_{Cn}^{e} = \frac{\gamma_{Cn}^{e}}{\gamma_{AIP}} \quad (1)$$

So the relational vector $R^e = (n_{C1}^{e}, n_{C2}^{e}, \dots, n_{Cn}^{e})$is obtained. Where it n_{Cn}^{e}represents the value of the real vector derived from the previous equation.

Step 1.3: Determination of the vector of weight coefficients

The vector of weight coefficients $w = (w_1, w_2, \dots, w_n)^T$ is calculated by the expert $e(1 \le e \le k)$using the following equation

:

$$w_j^e = \frac{\log_A(n_{Cn}^{e})}{\log_A\left(\prod_{J=1}^{n} n_{Cn}^{e}\right)}, A > 1 \quad (2)$$

where w_j^eit represents the weighting coefficients obtained according to expert evaluations e^{th} and the n_{Cn}^{e}elements of the realization vector *R.* The obtained values for the weighting coefficients must meet the condition that $\sum_{j=1}^{n} w_j^e = 1$.

By applying the Bonferroni aggregator shown in the following equation, the aggregated vector of weight coefficients is determined $w = (w_1, w_2, \dots, w_n)^T$:

$$W_j = \left(\frac{1}{k.(k-1)} . \sum_{x=1}^{k} \left(w_j^{(x)} \right)^p . \sum_{\substack{y=1 \\ Y \neq x}}^{k} \left(w_{ij}^{(y)} \right)^q \right)^{\frac{1}{p+q}} \quad (3)$$

The value of p and q are stabilization parameters and $p, q \ge 0$. The resulting weight coefficients should fulfill the condition that $\sum_{j=1}^{n} w_j = 1$.

DNMA (Double Normalization-based Multiple Aggregation) method is a newer method for showing alternatives [4]. Two different normalized (linear and vector) techniques are used, as well as three different coupling functions (full compensation - CCM, non-compensation - UCM and incomplete

compensation - ICM). The steps of applying this method are as follows [9]:

Step 1: Normalized decision matrix

The elements of the decision matrix are normalized with linear $(\hat{x}_{ij}^{1N})$normalization using the following equation:

$$\hat{x}_{ij}^{1N} = 1 - \frac{\left|x^{ij} - r_j\right|}{max\left\{\max_i x^{ij}, r_j\right\} - min\left\{\min_i x^{ij}, r_j\right\}} \quad (4)$$

The vector $(\hat{x}_{ij}^{2N})$is normalized using the following equation:

$$\hat{x}_{ij}^{2N} = 1 - \frac{\left|x^{ij} - r_j\right|}{\sqrt{\sum_{i=1}^{m}(x^{ij})^2 + \left(r_j\right)^2}} \quad (5)$$

The value $r_j$is the target value for $c_j$the criterion and is considered $\max_i x^{ij}$for both utility and $\min_i x^{ij}$cost criteria.

Step 2: Determining the weight of the criteria This step consists of three phases:

Step 2.1: In this phase, the standard deviation $(\sigma_j)$for the criterion $c_j$is determined with the following equation where *m is* the number of alternatives:

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}\left(\frac{x^{ij}}{\max_i x^{ij}} - \frac{1}{m}\sum_{i=1}^{m}\left(\frac{x^{ij}}{\max_i x^{ij}}\right)\right)^2}{m}} \quad (6)$$

Step 2.2: Values of the standard deviation calculated for the criteria se normalize with the following equation:

$$w_j^{\sigma} = \frac{\sigma_j}{\sum_{i=1}^{n}\sigma_j} \quad (7)$$

Step 2.3: Finally, the weights are adjusted with the following equation:

$$\widehat{w}_j = \frac{\sqrt{w_j^{\sigma}.w_j}}{\sum_{i=1}^{n}\sqrt{w_j^{\sigma}.w_j}} \quad (8)$$

Step 3: Calculating the aggregation model Three aggregation functions (CCM, UCM and ICM) are calculated separately for each alternative.

The CCM (Complete Compensation Model) is calculated using the following equation:

$$u_1(a_i) = \sum_{j=1}^{n}\frac{\widehat{w}_j.\hat{x}_{ij}^{1N}}{\max_i \hat{x}_{ij}^{1N}} \quad (9)$$

The UCM (non-compensatory model) is calculated using the following equation:

$$u_2(a_i) = \max_j \widehat{w}_j\left(\frac{1 - \hat{x}_{ij}^{1N}}{\max_i \hat{x}_{ij}^{1N}}\right) \quad (10)$$

The ICM (Incomplete Compensation Model) is calculated using the following equation:

$$u_3(a_i) = \prod_{j=1}^{n} \left(\frac{\hat{x}_{ij}^{2N}}{\max_i \hat{x}_{ij}^{2N}} \right)^{\hat{w}_j} \quad (11)$$

Step 4: Integration of utility values

The calculated utility functions are integrated with the following equation using the Euclidean principle of distance:

$$DN_i = w_1 \sqrt{\varphi \left(\frac{u_1(a_i)}{\max_i u_1(a_i)} \right)^2 + (1-\varphi) \left(\frac{m - r_{1(a_i)+1}}{m} \right)^2} - w_2 \sqrt{\varphi \left(\frac{u_2(a_i)}{\max_i u_2(a_i)} \right)^2 + (1-\varphi) \left(\frac{r_2(a_i)}{m} \right)^2} + w_3 \sqrt{\varphi \left(\frac{u_3(a_i)}{\max_i u_3(a_i)} \right)^2 + (1-\varphi) \left(\frac{m - r_3(a_i) + 1}{m} \right)^2} \quad (12)$$

In this case, the means $r_1(a_i)$and $r_3(a_i)$represent the ordinal number of the alternative $a_i$sorted by CCM and ICM functions in descending value (higher value first). On the other hand, $r_2(a_i)$it shows the sequence number in the obtained order according to the increasing value (smaller value first) for the UCM function used. The label $\varphi$is the relative importance of the child value used and is in the range [0.1]. It is considered that it can be taken as $\varphi = 0.5$. The coefficients $w_1, w_2, w_3$are obtained weights of the used functions CCM, UCM and ICM, respectively. The sum should be equal $w_1 + w_2 + w_3 = 1$. When determining the weights, if the decision maker attaches importance to a wider range of performance alternatives, he can set a higher value for w_1. In case the decision maker is not willing to take risks, i.e. to choose a poor alternative according to some criterion, he can assign a higher weight to w_2. However, the decision maker may assign a greater weight to $w_3$if he simultaneously considers overall performance and risk. Finally, the *DN* values are sorted in descending order, with the higher value alternatives being the best.

3 Ranking of companies in the European Union and Serbia according to the development of electronic business using the LMAW-DNMA method

When ranking the companies of the European Union and Serbia according to the development of electronic business based on the LMAW-DNMA method, the following criteria were used: C1 - Website, C2 - Use of Enterprise Resource Planning (ERP) and C3 - Use of Customer Relationship Management (CRM). According to statistics from Eurostat, they are good indicators of electronic business. Alternatives are the member states of the European Union and Serbia. Table 1 shows the criteria, alternatives and initial data for 2021.

Table 1. Enterprises adopting e-business applications, 2021 (% enterprise)

		Website	Use of Enterprise Resource Planning (ERP)	Use of Customer Relationship Management (CRM)
		C1	**C2**	**C3**
	E U	**78**	**38**	**35**
A1	**Belgium**	:	57	54
A2	**Bulgaria**	52	22	17
A3	**Czechia**	83	38	18
A4	**Denmark**	:	50	42
A5	**Germany**	89	38	45
A6	**Estonia**	:	23	23
A7	**Ireland**	82	24	32
A8	**Greece**	62	35	20
A9	**Spain**	77	49	40
A10	**France**	70	45	32
A11	**Croatia**	68	24	20
A12	**Italy**	75	32	27
A13	**Cyprus**	69	34	39
A14	**Latvia**	68	39	18
A15	**Lithuania**	78	45	32
A16	**Luxembourg**	81	40	35
A17	**Hungary**	63	21	15
A18	**Malta**	82	39	39
A19	**Netherlands**	92	43	52
A20	**Austria**	91	45	46
A21	**Poland**	71	32	32
A22	**Portugal**	62	52	25
A23	**Romania**	51	17	17
A24	**Slovenia**	83	36	22
A25	**Slovakia**	76	31	22
A26	**Finland**	96	48	46
A27	**Sweden**	91	35	38
	Norway	83	39	39
	Albania	44	35	24
	Montenegro ([1])	: *(in)*	: *(in)*	47
	North Macedonia	49	15	15
A28	**Serbia**	85	22	14
	Turkey	49	28	11
	Bosnia and Herzegovina	62	26	16

Note: 2021 EU aggregates for website variables excluding Belgium, Denmark and Estonia. (:) data not available. ([1]) Montenegro: data for enterprises with website and for use of ERP: unreliable

Source: Eurostat (isoc_ciweb) and (isoc_eb_iip)

In the countries of the European Union, the trend is to increase the electronic business of companies. This is clearly shown by the data in Table 2. For illustration, in 2021 compared to 2019, there was an increase in Enterprises with a website (from 77% to 78%), Use of Enterprise Resource Planning (ERP) (from 36% to 38 %) and Use of

Customer Relationship Management (CRM) (from 33% to 35%).

Table 2. Adoption of e-business applications in enterprises, EU, 2019 and 2021 (% of enterprises)

	2019	**2021**
Enterprises with a website	77	78
Use of Enterprise Resource Planning (ERP)	36	38
Use of Customer Relationship Management (CRM)	33	35

Source: Eurostat (isoc_ciweb) and (isoc_eb_iip)

In Serbia, the percentage of companies that use the website is higher than in North Macedonia and Bosnia and Herzegovina. However, compared to Croatia and Slovenia, the percentage of companies in Serbia that use the website is lower. The percentage of companies in Serbia that use *Use of Enterprise Resource Planning (ERP)* is lower than in Croatia and Slovenia. Compared to North Macedonia, it is larger, but smaller compared to Bosnia and Herzegovina. In Serbia, the percentage of companies that use *Use of Customer Relationship Management (CRM)* is lower than in Croatia and Slovenia. Likewise, it is smaller compared to North Macedonia and Bosnia and Herzegovina. All in all, the level of development of the electronic business of companies in Serbia is unsatisfactory, especially in relation to the countries of the European Union. In the future, due to its importance, it is therefore necessary that companies in Serbia perform their business activities electronically as much as possible. For these needs, they should invest more in information and communication technology.

The weight coefficients of the criteria were calculated using the LMAW method. Table 3 shows the prioritization scale for those needs.

Table 3. Prioritization Scale

Linguistic Variables	**Abbreviation**	**Prioritization**
Absolutely Low	AL	1
Very Low	VL	1.5
Low	L	2
Medium	M	2.5
Equal	E	3
Medium High	MH	3.5
High	H	4
Very High	VH	4.5
Absolutely High	AH	5

Table 4 shows the criteria evaluation procedure and, as a result, their weighted coefficient.

Table 4. Evaluation and weight coefficients of the criteria

KIND	1	1	1
	C1	**C2**	**C3**
E1	**H**	**AH**	**H**
E2	**VH**	**VH**	**MH**
E3	**H**	**MH**	**VH**
E4	**MH**	**H**	**H**

E5	**VH**	**VH**	**MH**
ϒAIP	0.5		
	C1	**C2**	**C3**
R1	8	10	8
R2	9	9	7
R3	8	7	9
R4	7	8	8
R5	9	9	7
Weight Coefficients Vector	**C1**	**C2**	**C3**
W1j	0.322	0.356	0.322
W2j	0.347	0.347	0.307
W3j	0.334	0.313	0.353
W4j	0.319	0.341	0.341
W5j	0.347	0.347	0.307
Aggregated Fuzzy Vectors	**C1**	**C2**	**C3**
W1j	0.022	0.024	0.021
W2j	0.023	0.024	0.020
W3j	0.022	0.022	0.023
W4j	0.022	0.023	0.022
W5j	0.023	0.024	0.020
SUM	0.111	0.116	0.106
Aggregated Weight Coefficient Vectors	0.3335	0.3405	0.3257

According to the LMAW method, the most important criterion is C2 - Use of Enterprise Resource Planning (ERP). By increasing the use of Use of Enterprise Resource Planning (ERP), it is possible to influence the increase in the performance of companies in the countries of the European Union and Serbia. Tables 5 - 11 show the procedure and results of applying the LMAW-DNMA method.

Table 5. Initial Matrix

INITIAL MATRIX	**KIND**	1	1	1
	Weight	0.3335	0.3405	0.3257
		C1	**C2**	**C3**
	A1	0	57	54
	A2	52	22	17
	A3	83	38	18
	A4	0	50	42
	A5	89	38	45
	A6	0	23	23
	A7	82	24	32
	A8	62	35	20
	A9	77	49	40
	A10	70	45	32
	A11	68	24	20
	A12	75	32	27
	A13	69	34	39
	A14	68	39	18
	A15	78	45	32

	A16	81	40	35
	A17	63	21	15
	A18	82	39	39
	A19	92	43	52
	A20	91	45	46
	A21	71	32	32
	A22	62	52	25
	A23	51	17	17
	A24	83	36	22
	A25	76	31	22
	A26	96	48	46
	A27	91	35	38
	A28	85	22	14
	MAX	96.0000	57.0000	54.0000
	MIN	0.0000	17.0000	14.0000

Table 6. Linear Normalization Matrix

Linear Normalization MATRIX		**C1**	**C2**	**C3**	**MAX**
	A1	0.0000	1.0000	1.0000	1.0000
	A2	0.5417	0.1250	0.0750	0.5417
	A3	0.8646	0.5250	0.1000	0.8646
	A4	0.0000	0.8250	0.7000	0.8250
	A5	0.9271	0.5250	0.7750	0.9271
	A6	0.0000	0.1500	0.2250	0.2250
	A7	0.8542	0.1750	0.4500	0.8542
	A8	0.6458	0.4500	0.1500	0.6458
	A9	0.8021	0.8000	0.6500	0.8021
	A10	0.7292	0.7000	0.4500	0.7292
	A11	0.7083	0.1750	0.1500	0.7083
	A12	0.7813	0.3750	0.3250	0.7813
	A13	0.7188	0.4250	0.6250	0.7188
	A14	0.7083	0.5500	0.1000	0.7083
	A15	0.8125	0.7000	0.4500	0.8125
	A16	0.8438	0.5750	0.5250	0.8438
	A17	0.6563	0.1000	0.0250	0.6563
	A18	0.8542	0.5500	0.6250	0.8542
	A19	0.9583	0.6500	0.9500	0.9583
	A20	0.9479	0.7000	0.8000	0.9479
	A21	0.7396	0.3750	0.4500	0.7396
	A22	0.6458	0.8750	0.2750	0.8750
	A23	0.5313	0.0000	0.0750	0.5313
	A24	0.8646	0.4750	0.2000	0.8646
	A25	0.7917	0.3500	0.2000	0.7917
	A26	1.0000	0.7750	0.8000	1.0000
	A27	0.9479	0.4500	0.6000	0.9479
	A28	0.8854	0.1250	0.0000	0.8854

Table 7. Vector Normalization Matrix

Vector Normalization MATRIX		C1	C2	C3	MAX
	A1	0.0000	1.0000	1.0000	1.0000
	A2	0.8889	0.8315	0.7971	0.8889
	A3	0.9672	0.9085	0.8026	0.9672
	A4	0.0000	0.9663	0.9342	0.9663
	A5	0.9823	0.9085	0.9507	0.9823
	A6	0.0000	0.8363	0.8300	0.8363
	A7	0.9646	0.8411	0.8794	0.9646
	A8	0.9141	0.8941	0.8136	0.9141
	A9	0.9520	0.9615	0.9232	0.9615
	A10	0.9343	0.9422	0.8794	0.9422
	A11	0.9293	0.8411	0.8136	0.9293
	A12	0.9470	0.8797	0.8520	0.9470
	A13	0.9318	0.8893	0.9178	0.9318
	A14	0.9293	0.9133	0.8026	0.9293
	A15	0.9545	0.9422	0.8794	0.9545
	A16	0.9621	0.9182	0.8958	0.9621
	A17	0.9166	0.8267	0.7862	0.9166
	A18	0.9646	0.9133	0.9178	0.9646
	A19	0.9899	0.9326	0.9890	0.9899
	A20	0.9874	0.9422	0.9561	0.9874
	A21	0.9368	0.8797	0.8794	0.9368
	A22	0.9141	0.9759	0.8410	0.9759
	A23	0.8863	0.8074	0.7971	0.8863
	A24	0.9672	0.8989	0.8245	0.9672
	A25	0.9495	0.8748	0.8245	0.9495
	A26	1.0000	0.9567	0.9561	1.0000
	A27	0.9874	0.8941	0.9123	0.9874
	A28	0.9722	0.8315	0.7807	0.9722
	Adj Wj	0.2973	0.3406	0.3622	

Table 8. CCM (Complete Compensatory Model)

CCM (Complete Compensatory Model)	u1(ai)	C1	C2	C3	SUM
	A1	0.0000	0.3406	0.3622	0.7027
	A2	0.2973	0.0786	0.0502	0.4260
	A3	0.2973	0.2068	0.0419	0.5459
	A4	0.0000	0.3406	0.3073	0.6479
	A5	0.2973	0.1929	0.3028	0.7929
	A6	0.0000	0.2270	0.3622	0.5892
	A7	0.2973	0.0698	0.1908	0.5578
	A8	0.2973	0.2373	0.0841	0.6187
	A9	0.2973	0.3397	0.2935	0.9304
	A10	0.2973	0.3269	0.2235	0.8477
	A11	0.2973	0.0841	0.0767	0.4581
	A12	0.2973	0.1635	0.1507	0.6114
	A13	0.2973	0.2014	0.3150	0.8136
	A14	0.2973	0.2644	0.0511	0.6128
	A15	0.2973	0.2934	0.2006	0.7913

	A16	0.2973	0.2321	0.2254	0.7547
	A17	0.2973	0.0519	0.0138	0.3629
	A18	0.2973	0.2193	0.2650	0.7816
	A19	0.2973	0.2310	0.3590	0.8873
	A20	0.2973	0.2515	0.3057	0.8544
	A21	0.2973	0.1727	0.2204	0.6903
	A22	0.2194	0.3406	0.1138	0.6738
	A23	0.2973	0.0000	0.0511	0.3484
	A24	0.2973	0.1871	0.0838	0.5681
	A25	0.2973	0.1506	0.0915	0.5393
	A26	0.2973	0.2639	0.2898	0.8509
	A27	0.2973	0.1617	0.2293	0.6882
	A28	0.2973	0.0481	0.0000	0.3453

Table 9. UCM (Uncompensatory Model)

UCM (Uncompensatory Model)	**u2(ai)**	**C1**	**C2**	**C3**	**MAX**
	A1	0.0000	0.0000	0.0000	
	A2	0.0000	0.2620	0.3120	0.3120
	A3	0.0000	0.1338	0.3203	0.3203
	A4	0.0000	0.0000	0.0549	0.0549
	A5	0.0000	0.1477	0.0594	0.1477
	A6	0.0000	0.1135	0.0000	0.1135
	A7	0.0000	0.2708	0.1714	0.2708
	A8	0.0000	0.1033	0.2781	0.2781
	A9	0.0000	0.0009	0.0687	0.0687
	A10	0.0000	0.0136	0.1387	0.1387
	A11	0.0000	0.2564	0.2855	0.2855
	A12	0.0000	0.1771	0.2115	0.2115
	A13	0.0000	0.1392	0.0472	0.1392
	A14	0.0000	0.0761	0.3111	0.3111
	A15	0.0000	0.0472	0.1616	0.1616
	A16	0.0000	0.1085	0.1368	0.1368
	A17	0.0000	0.2887	0.3484	0.3484
	A18	0.0000	0.1213	0.0972	0.1213
	A19	0.0000	0.1096	0.0031	0.1096
	A20	0.0000	0.0891	0.0565	0.0891
	A21	0.0000	0.1679	0.1418	0.1679
	A22	0.0779	0.0000	0.2484	0.2484
	A23	0.0000	0.3406	0.3111	0.3406
	A24	0.0000	0.1535	0.2784	0.2784
	A25	0.0000	0.1900	0.2707	0.2707
	A26	0.0000	0.0766	0.0724	0.0766
	A27	0.0000	0.1789	0.1329	0.1789
	A28	0.0000	0.2925	0.3622	0.3622

Table 10. ICM (Incomplete Compensatory Model)

ICM (Incomplete Compensatory Model)	u3(ai)	C1	C2	C3	MAX
	A1	0.0000	1.0000	1.0000	0.0000
	A2	1.0000	0.9775	0.9613	0.9397
	A3	1.0000	0.9789	0.9347	0.9150
	A4	0.0000	1.0000	0.9878	0.0000
	A5	1.0000	0.9738	0.9882	0.9623
	A6	0.0000	1.0000	0.9973	0.0000
	A7	1.0000	0.9544	0.9670	0.9230
	A8	1.0000	0.9925	0.9587	0.9515
	A9	0.9971	1.0000	0.9854	0.9825
	A10	0.9975	1.0000	0.9753	0.9729
	A11	1.0000	0.9666	0.9530	0.9212
	A12	1.0000	0.9752	0.9624	0.9386
	A13	1.0000	0.9842	0.9945	0.9788
	A14	1.0000	0.9941	0.9483	0.9427
	A15	1.0000	0.9956	0.9707	0.9665
	A16	1.0000	0.9842	0.9745	0.9591
	A17	1.0000	0.9654	0.9459	0.9132
	A18	1.0000	0.9816	0.9821	0.9640
	A19	1.0000	0.9799	0.9997	0.9796
	A20	1.0000	0.9842	0.9884	0.9728
	A21	1.0000	0.9788	0.9773	0.9566
	A22	0.9807	1.0000	0.9475	0.9293
	A23	1.0000	0.9688	0.9623	0.9322
	A24	1.0000	0.9754	0.9439	0.9206
	A25	1.0000	0.9725	0.9502	0.9241
	A26	1.0000	0.9850	0.9839	0.9692
	A27	1.0000	0.9668	0.9718	0.9395
	A28	1.0000	0.9482	0.9236	0.8757

Table 11. Ranking of alternatives

											w1	**w2**	**w3**	
											0.6	**0.1**	**0.3**	
		CCM		**φ**	**UCM**		**φ**	**ICM**		**φ**	**Utility Values**			**Rank Order**
		u1(ai)	**Rank**	**0.5**	**u2(ai)**	**Rank**	**0.5**	**u3(ai)**	**Rank**	**0.5**				
Belgium	**A1**	0.7027	11	0.7013	0.0000	1	0.0253	0.0000	26	0.0758	0.4461	0.4461		**26**
Bulgaria	**A2**	0.4260	25	0.3391	0.3120	24	0.8593	0.9397	14	0.7752	0.5220	0.5220		**21**
Czechia	**A3**	0.5459	22	0.4510	0.3203	25	0.8886	0.9150	23	0.6757	0.5622	0.5622		**19**
Denmark	**A4**	0.6479	15	0.6062	0.0549	2	0.1184	0.0000	26	0.0758	0.3983	0.3983		**27**
Germany	**A5**	0.7929	7	0.8196	0.1477	12	0.4183	0.9623	9	0.8572	0.7907	0.7907		**8**
Estonia	**A6**	0.5892	19	0.5141	0.1135	7	0.2835	0.0000	26	0.0758	0.3595	0.3595		**28**
Ireland	**A7**	0.5578	21	0.4696	0.2708	19	0.7139	0.9230	20	0.7021	0.5638	0.5638		**18**
Greece	**A8**	0.6187	16	0.5734	0.2781	20	0.7415	0.9515	12	0.8082	0.6607	0.6607		**14**
Spain	**A9**	0.9304	1	1.0000	0.0687	3	0.1540	0.9825	1	1.0000	0.9154	0.9154		**1**
France	**A10**	0.8477	5	0.8845	0.1387	10	0.3702	0.9729	4	0.9428	0.8506	0.8506		**4**
Croatia	**A11**	0.4581	24	0.3703	0.2855	22	0.7870	0.9212	21	0.6931	0.5088	0.5088		**22**
Italy	**A12**	0.6114	18	0.5413	0.2115	16	0.5777	0.9386	16	0.7510	0.6079	0.6079		**16**
Cyprus	**A13**	0.8136	6	0.8483	0.1392	11	0.3886	0.9788	3	0.9630	0.8368	0.8368		**5**

Latvia	**A14**	0.6128	17	0.5556	0.3111	23	0.8403	0.9427	13	0.7897	0.6543	0.6543	**15**
Lithuania	**A15**	0.7913	8	0.8018	0.1616	13	0.4553	0.9665	7	0.8902	0.7937	0.7937	**7**
Luxembourg	**A16**	0.7547	10	0.7478	0.1368	9	0.3507	0.9591	10	0.8406	0.7359	0.7359	**10**
Hungary	**A17**	0.3629	26	0.2860	0.3484	27	0.9631	0.9132	24	0.6693	0.4687	0.4687	**24**
Malta	**A18**	0.7816	9	0.7797	0.1213	8	0.3112	0.9640	8	0.8733	0.7609	0.7609	**9**
Netherlands	**A19**	0.8873	2	0.9590	0.1096	6	0.2621	0.9796	2	0.9808	0.8958	0.8958	**2**
Austria	**A20**	0.8544	3	0.9234	0.0891	5	0.2149	0.9728	5	0.9260	0.8534	0.8534	**3**
Poland	**A21**	0.6903	12	0.6779	0.1679	14	0.4821	0.9566	11	0.8250	0.7024	0.7024	**11**
Portugal	**A22**	0.6738	14	0.6369	0.2484	17	0.6476	0.9293	18	0.7242	0.6642	0.6642	**13**
Romania	**A23**	0.3484	27	0.2695	0.3406	26	0.9344	0.9322	17	0.7362	0.4760	0.4760	**23**
Slovenia	**A24**	0.5681	20	0.4879	0.2784	21	0.7594	0.9206	22	0.6857	0.5744	0.5744	**17**
Slovakia	**A25**	0.5393	23	0.4370	0.2707	18	0.6971	0.9241	19	0.7114	0.5453	0.5453	**20**
Finland	**A26**	0.8509	4	0.9038	0.0766	4	0.1805	0.9692	6	0.9077	0.8326	0.8326	**6**
Sweden	**A27**	0.6882	13	0.6609	0.1789	15	0.5152	0.9395	15	0.7630	0.6770	0.6770	**12**
Serbia	**A28**	0.3453	28	0.2637	0.3622	28	1.0000	0.8757	25	0.6383	0.4497	0.4497	**25**
	MAX	0.9304			0.3622			0.9825					

Therefore, according to the results of the LMAW-DNMA method, the top five companies of the European Union countries in terms of the development of electronic business fall in the following order: Spain, Netherlands, Austria, France and Cyprus. Companies from Germany (eighth place), France (fourth place) and Italy (sixteenth place) are positioned at an enviable level. The worst position was taken by Estonian companies. Romanian companies are positioned on the twenty-third place.

Serbian companies are positioned in twenty-fifth place. They are in relation to the companies of the European Union, and in the region, that is. Croatia (twenty-second place) and Slovenia (seventeenth place) are worse positioned. All of this in itself leads to the conclusion that companies in Serbia should, given its importance, pay more attention to the development of e-business in the future.

5 Electronic business of European Union companies by size

In the European Union, the development of electronic business of companies varies by size. The data in Table 12 clearly supports this. The development of electronic business in large companies is significantly higher than in small and medium-sized ones. Likewise, the development of electronic business in medium-sized companies is higher than in small ones. The conclusion is that the size of the company significantly affects the level of application of electronic business. Larger companies are able to invest more in information and communication technology than smaller ones.

Table 12. Enterprises adopting e-business applications, by size class, EU, 2021
(% of enterprises)

	Variables	**All enterprises**	**Small**	**Medium**	**Large**
Enterprises with a website	e_web	78	75	89	94
Use of Enterprise Resource Planning (ERP)	e_erp1	38	33	62	81
Use of Customer Relationship Management (CRM)	e_crm	35	31	50	65

Notes: 2021 EU aggregates for website variables excluding Belgium, Denmark and Estonia.
Source: Eurostat (isoc_ciweb) and (isoc_eb_iip)

6 Sectoral analysis of the electronic business of companies in the countries of the European Union

In any case, the development of electronic business of companies in the countries of the European Union is different in individual sectors, partly caused by differences in the very nature of business. This is clearly seen from the data presented in Table 13.

Table 13. Enterprises having ERP software package, and Enterprises using Customer Relationship Management (CRM), by economic activity, EU, 2021 (% enterprises)

	Enterprises who have an ERP software package	**Enterprises using analytical CRM**	**Enterprises using operational CRM**
	e_erp1	**E_CRMAN**	**E_CRMSTR**
Information and communication	54	42	63
Manufacturing	49	36	44
Electricity, gas, steam and air conditioning; water supply, sewerage, waste management and remediation activities	48	17	43
Wholesale and retail trade; repair of motor vehicles and motorcycles	46	19	42
Real estate activities	44	28	41
Professional, scientific and technical activities	39	16	40
Retail trade	33	18	35
Administrative and support service activities	31	19	34
Transport and storage	30	21	29
Accommodation	28	12	24
Construction	26	7	22
All activities	38	19	34

Source: Eurostat (isoc_eb_iip)

The highest percentage of Enterprises who have ERP software package, Enterprises using analytical CRM and Enterprises using operational CRM is in the Information and communication sector. It is the smallest in the Construction sector. In the Wholesale and retail trade sector; repair of motor vehicles and motorcycles and Retail trade electronic business is at an enviable level. The character itself, among other things, affects the level of development of electronic business of companies from different sectors. Investment needs in information and communication technology are different for each sector.

7 Conclusion

Empirical research on electronic business of companies in the European Union and Serbia leads to the following conclusions:

In the countries of the European Union, the trend is to increase the electronic business of companies. Thus, for example, in 2021 compared to 2019, there was an increase in Enterprises with a website, Use of Enterprise Resource Planning (ERP) and Use of Customer Relationship Management (CRM). According to the results of the LMAW-DNMA method, the top five companies of the European Union countries in terms of the development of electronic business are in order: Spain, Netherlands, Austria, France and Cyprus. As far as the leading countries of the European Union are concerned, the positioning of companies from Germany (eighth place), France (fourth place) and Italy (sixteenth place) is at an enviable level. The worst position was taken by Estonian companies. Romanian companies are positioned on the twenty-third place.

As far as Serbian companies are concerned, they are positioned in twenty-fifth place. They are positioned worse in relation to the companies of the European Union, and in the region, namely Croatia (twenty-second place) and Slovenia (seventeenth place). In Serbia, the percentage of companies that use the website is higher than in North Macedonia and Bosnia and Herzegovina. However, compared to Croatia and Slovenia, the percentage of companies in Serbia that use the website is lower. The percentage of companies in Serbia that use *Use of Enterprise Resource Planning (ERP)* is lower than in Croatia and Slovenia. Compared to North Macedonia, it is larger, but smaller compared to Bosnia and Herzegovina. In Serbia, the percentage of companies that use Use of Customer Relationship Management (CRM) is lower than in Croatia and Slovenia. It is also smaller compared to North Macedonia and Bosnia and Herzegovina. Unsatisfactory level of development of electronic business of companies in Serbia, especially in relation to developed countries of the European Union. In the future, due to its importance, it is necessary for companies in Serbia to develop and use electronic business as much as possible in their operations, and for these needs to invest in modern information and communication technology.

In the European Union, the development of electronic business of companies varies by size. It is significantly higher in large companies than in small and medium-sized ones. Likewise, it is higher in medium-sized than in small enterprises. The size of the company therefore significantly affects the level of application of electronic business. Compared to small and larger companies, they are also in a better position to invest in information and communication technology.

The highest percentage of Enterprises who have ERP software package, Enterprises using analytical CRM and Enterprises using operational CRM is in the Information and communication sector, and the lowest is in the Construction sector. In the Wholesale and retail trade sector; repair of motor vehicles and motorcycles and Retail trade electronic business is at an enviable level. Therefore, the s am sector's character, among other things, affects the level of development of the company's electronic business, as well as the needs for investment in information and communication technology.

References

[1] K. Alam, M.A. Ali, M. Erdiaw-Kwasie, M. Shahiduzzaman, E. Velayutham, P.A. Murray, R. Wiesner, (2022). Impact of ICTs on Innovation and Performance of Firms: Do Start-ups, Regional Proximity and Skills Matter? *Sustainability,* 14, 5801. https://doi.org/10.3390/su14105801

[2] J.M. Argilés-Bosch, J. Garcia-Blandón, & D. Ravenda, (2022). Cost behavior in e-commerce firms. *Electron Comm Res* . https://doi.org/10.1007/s10660-021-09528-2

[3] D. Božanić, D. Pamučar, A. Milić, D. Marinković, and N. Komazec. 2022. Modification of the Logarithm Methodology of Additive Weights (LMAW) by a Triangular Fuzzy Number and Its Application in Multi-Criteria Decision Making. *Axioms,* 11(3), 89. https://doi.org/10.3390/axioms11030089

[4] G. Demir, (2022). Küresel Çok Boyutlu Yoksulluk Endeksinin Bulanık LMAW Yöntemi İle Değınızılı. *Sosyal Bilimlerde Nicel Araştırmalar Dergisi* , 2(1), 67-77.

[5] F. Ezer, (2020). Multi-criteria Decision-making comprehensive approach from past to present. Seçkin Publications.

[6] S. Gu, B. Slusarczyk, S. Hajizada, I. Kovalyova, A. Sakhbieva, (2021). Impact of the COVID-19 Pandemic on Online Consumer Purchasing Behavior. *J. Theor. Appl. Electron. Commerce. Res* ., 16, 2263–2281. https://doi.org/10.3390/jtaer16060125

[7] J.J. Jorgensen, V.S. Zuiker, L. Manikowske, & M. LeHew, (2022). Impact of Communication Technologies on Small Business Success. *Journal of Small Business Strategy,* 32(3), 142–157. https://doi.org/10.53703/001c.36359

[8] S. Kazakov, J.L. Ruiz-Alba, and M.M. Muñoz, (2021). The impact of information and communication technology and internal market orientation blending on organizational performance in small and medium enterprises. European Journal of Management and Business Economics , 30(2), 129-151. https://doi.org/10.1108/EJMBE-04-2020-0068

[9] H. Liao, & X. Wu, (2020). DNMA: A double normalization-based multiple aggregation methods for multi-expert multi-criteria decision making. *Omega,* 94, 102058. https://doi.org/10.1016/j.omega.2019.04.001

[10] A. Liu, M. Osewe, Y. Shi, X. Zhen, Y. Wu, (2022). Cross-Border E-Commerce Development and Challenges in China: A Systematic Literature Review. *J. Theor. Appl. Electron. Commerce. Res*., 17, 69–88. https://doi.org/10.3390/jtaer17010004

[11] R. Lukic, S. Lalic, and D. Vojteski Kljenak, (2016). Research and Development Costs in Retail Trade. *Management and Economics Review*, 1(2), 170-182.

[12] R. Lukic. (2022). Application of the MARCOS Method in Analysis of the Positioning of Electronic Trade of the European Union and Serbia. *Informatica Economica*, 26(3), 50-63. DOI: 10.24818/issn14531305/26.3.2022.05

[13] R. Lukic. (2023). Measurement and analysis of the information performance of companies in the European Union and Serbia based on the fuzzy LMAW and MARCOS methods. *Informatica Economica*, 27(1), 17 – 31. DOI: 10.24818/issn14531305/27.1.2023.02

[14] D. Pamučar, M. Žižović, S. Biswas, D. Božanić. (2021). A new logarithm methodology of additive weights (LMAW) for multi-criteria decision-making: Application in logistics. *Facta Univ. Sir. Mech. Eng* ., 2021, 19, 361–380. https://doi.org/10.22190/FUME210214031P

[15] A. Puška, D. Božanić, M. Nedeljković, M. Janošević. (2022). Green Supplier Selection in an Uncertain Environment in Agriculture Using a Hybrid MCDM Model: Z-Numbers–Fuzzy LMAW–Fuzzy CRADIS Model. *Axioms* , 11, 427. https://doi.org/10.3390/ axioms11090427

[16] A.U. Rehman, S. Bashir, A. Mahmood, H. Karim, and Z. Nawaz. (2022). Does e-shopping service quality enhance customers' e-shopping adoption? An extended perspective of unified theory of acceptance and use of technology. *PLoS ONE*, 17(2). e0263652. https://doi.org/10.1371/journal.pone.0263652

[17] Ž. Stević, D. Pamučar, A. Puška, and P. Chatterjee. (2020). Sustainable supplier selection in healthcare industries using a new MCDM method: Measurement of alternatives and ranking according to Compromise solution (MARCOS). *Computers & Industrial Engineering* , 140, 106231. https://doi.org/10.1016/j.cie.2019.106231

[18] Ž. Stević, N.A. Brković. (2020). Novel Integrated FUCOM-MARCOS Model for Evaluation of Human Resources in a Transport Company. *Logistics*, 4, 4. https://doi.org/10.3390/logistics4010004

[19] D. Tolstoy, E.R. Nordman, and U. Wu. (2022). The indirect effect of online marketing capabilities on the international performance of e-commerce SMEs. *International Business Review*, 31(3), 101946. https://doi.org/10.1016/j.ibusrev.2021.101946

[20] R.R. Yager, (2009). He generalized Bonferroni mean operators for multi-criteria aggregation. *International Journal of Approximate Reasoning*, 50(8), 1279-1286. https://doi.org/10.1016/j.ijar.2009.06.004

Radojko Lukic, PhD, full professor at the Faculty of Economics in Belgrade, where he graduated, master's and doctorate. He teaches the courses Accounting of trading companies, Accounting in banking and insurance and Special accounting at basic academic studies, as well as at several courses at master's studies (Organization of accounting information systems, Auditing in banks and Accounting for insurance companies). He teaches Cost Management in doctoral studies. He has published several scientific and professional works (books, reports, articles, etc.) in the field of accounting and financial management in the service sector. He is the co-author of several studies