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EVALUATION OF ICT USAGES IN VIRTUAL BUSINESS BY APPLYING MCDM METHODS

Juozas MERKEVIČIUS[1], Richa YADAV[2*]

[1,2]*Department of Business Technologies and Entrepreneurship, Faculty of Business Management, Vilnius Gediminas Technical University, Sauletekio av. 11, LT-10223, Vilnius, Lithuania*

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Abstract. The purpose of this study is to analyse integration and use of information and communication technologies (ICT) in virtual business. Current state of development of information and communication technology (ICT) connects individuals across time and space in one common environment that is accessible for anyone, creating the virtual world. ICT allows formation of virtual teams to accomplish various functions in work, education and private life. The statistical data helps us to know information about functioning of virtual business and their growth. The article concerns the techniques for the assessment of ICT use in virtual businesses. Virtual business, because of absence long year practise, facing specifics problems, different from traditional business. The ICT use in every businesses endeavour has differences. Novelty of this article The approach provided by this research include some methods for multi criteria decision support by applying SAW and other methods. On the case study we demonstrate the evaluation of ICT usage in business in Lithuania with comparison of other countries. The SAW method provide the structure of decision making which can help us to evaluate the usage of ICT in business.

Keywords: ICT, Virtual business, MCDM Methods, Simple Additive Weighting, Globalization, Internet, Decision making.

Introduction

Advances in Information and Communication Technology (ICT) and patterns, for example, nimbleness, globalization, and expanding demands for items and administrations with high efficiency have motivated distinctive organizations to participate and meet up to investigate business openings and satisfy client undertakings. Advancement of the Internet and fast changes in client demands for broadened administrations and items have persuaded organizations toward a new collaboration mapping including geographically disperst people and organizations that works as one team to accomplish the objectives (Germain, 2011). This collaboration is bolstered by PC systems. The changing business circumstance of organizations and client needs have persuaded specialists to present virtual business thought. Virtual groups, virtual workspaces, and virtual specialists are characterized in such broadened undertakings.

Since VOs have no physical limits, their worldwide reach has the potential for exponential productive increment, which requires developing the capacity for quick basic leadership. Human capital, especially virtual group administration, is fundamental for this quick basic leadership condition (Jawadia *et all*, 2013). The multimodal reality and the inalienable structure in VOs frequently require e-pioneers to participate in complex basic leadership forms. Along these lines, methodologies ought to incorporate successful communication by pioneers with their groups and the nearby administration of human capital (D'Urso *et all*, 2015).

Davidow and Malone (1992) noted that a VO extends the concepts of time and modification in response to immediate market demands. An organization is virtual in the sense that it has little if any physical presence and relies on telecommunications and the Internet. VOs tend to be agile, flexible, and fluid. Thus, a VO includes people, assets, and ideas linked by technology with no physical building. Often, the virtual employee works remotely from home and employs the Internet to maintain connection to the company. VOs reflect two different types of structures. First, employees work for a common entity with corporate goals. In this scenario, employees may work in

* Corresponding author. E-mail: *richa.yadav@stud.vgtu.lt*

virtual groups from different geographical locations. Second, the design of a VO could include different companies that share a common enterprise to deliver products or services in an effective and lucrative manner. These are actually a merger of all corporate divisions into the VO. These two VO structures enable organizations to focus on their markets to meet financial goals. Since the initial introduction of VOs, they have become popular due to low investment requirements, easy start-up procedures and cost and quick response time to and from their customers. This ease of setup enables many VOs that offer various types of services to merge. A Google search will reveal many VOs, ranging from virtual doctors (Teledoc) to virtual diet centers (Weight Watchers). Additionally, VOs include organizations that only have a virtual presence such as Amazon.com, Rakuten.com, or Overstock.com. Many VOs rely on their parent company to outsource. The primary benefit for outsourcing for the parent company is that the VO can control expenses, enable greater flexibility, and generate higher volume sales (D'Urso et all, 2015).

Aim of the research: to Evaluate of ICT usage, that influence expandice of virtual business in Lithuania with comparison of other countries. ***Research tasks***: 1) to analyse the chances of application of multicriteria decision making methods for evaluation of ICT usage in virtual business; 2) to exhibit the assessment of ICT use in business in Lithuania with comparison of different countries; 3) to make observational research going to demonstrate to potential outcomes generally accepted methods to assess countries by ICT use in virtual business.

Research methodology: methods of comparison and summarization, statistical data processing and a multicriteria analysis used during conduction of the research.

1. Theoretical background

The specifics of the virtual organizations and the issues of virtual business in separate aspects were discussed by Bekkers (2003), Ginevičius, Paliulis and others (2006), Duoba, Savanevičienė (2010), Tamošiūnaitė (2011), Verburg, Bosch-Sijtsema, Vartiainen (2013), Čulo (2016) and others. The main advantage of a virtual organization is the sharing of knowledge, experience and competence (Goldman et al. 1995). Unlike traditional groups, virtual teams work in spite of space, time, and organizational boundaries, using communications that are reinforced by communications technology networks. Clark (2014) points out that the ability to deploy an office in different locations is beneficial for both the employee and the employer. For employees, this helps to avoid congestion and the time spent on traveling to and from work much more efficiently. In the opinion of this author, less stress is experienced in working at home, but as one of the disadvantages of working at home, the lack of loyalty to the organization is due to weak social ties between the members of the organization. According to Franke (2001), despite the concept of a virtual organization, which characterizes important advantages, there are still major obstacles that need to be addressed: lack of coordination; Geographical distribution of members of the organization (distance and time differences are caused by the use of information technology, which reduces the satisfaction of their work due to physical isolation and the absence of a social environment specific to the traditional workplace); technology dependency; a complex system of staff promotion; lack of loyalty to the organization.

Differences in distance and time involve collaboration between information technologies. The members of the organization meet irregularly, so when communicating with information technology alone, much of the informal, personal and tactical aspects of communication that are often needed to achieve common denominators, agreements or learning within the organization are lost (Hinds, Kiesler 1995). According to Duoba (2009) As a result of changes in the needs of consumers and employees of organizations in the 20th century, grow of networking, influenced by the evolution of information and communication technologies (ITC), led to the emergence of virtual organizations. Korsakiene and co-authors (2006) argue that one of the reasons for the emergence of virtual organizations is the change in the operating conditions of organizations in the context of globalization processes. The emergence of a global virtual market, operating mainly through computer networks, has eliminated the boundaries between different national markets in virtual space, as users of different geographic locations, including suppliers and manufacturers, have access to it in the physical trading of products and services in a non-physical space. The globalization of competition is not just a virtual space - the ever-expanding borders of the European Union, the changing laws of international trade and similar political decisions create a framework for cooperation between companies from different countries, cultures and resources. In this case, the creation of a virtual business is one of the strategies to ensure the success of the organization. Most of authors agree, that information and communication technologies (ITC) directly responsible for grow of virtual business.

2. Evaluation of ICT usage in business in Lithuania with comparison of other countries

For evaluation of ITC usage in business in Lithuania was used multiple-criteria decision-making and multiple-criteria decision analysis. MCDM or MCDA are well-known acronyms for multiple-criteria decision-making and multiple-criteria decision analysis. MCDM is concerned with structuring and solving decision and planning problems involving multiple criteria. The purpose is to support decision makers facing such problems unique optimal solution for such problems and it is necessary to use decision maker's preferences to differentiate between solutions. For this research we used The Technique for Order of Preference by Similarity to Ideal Solution TOPSIS method and the

SAW (Simple Additive Weighting) method. For the assessment of ICT utilization in business in Lithuania with the examination of alternate countries, the beneath statistics are utilized.

Table1. Usage of ICT in all businesses (10 or more persons employed) (https://stats.oecd.org)

Country/ Year	2013	2014	2015	2016	2017
LITHUANIA	23.6	20.16	20.25	16.79	22.86
AUSTRIA	18.6	24.28	21.06	23.4	21.78
DENMARK	28.67	30.4	30.28	31.91	32.5
HUNGARY	16.27	17.34	16.11	19.72	19.92
GERMANY	13.38	13.64	13.46	17.34	22.02

The numbers in the table demonstrates the percentage use of ICT in all organizations of a country for that specific year. In the all analysed countries usage of ICT constatny grows.

2.1. Evaluation using TOPSIS Method

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multicriteria decision-making approach created by Hwang and Yoon (1981). It is a compensatory aggregation method based on the concept that the best alternative should have the shortest geometric distance to a positive ideal solution (PIS) and the geometric farthest distance from a negative ideal solution (NIS) (Krohling and Pacheco, 2015).

The TOPSIS process is carried out as follow:

STEP 1: Construct the decision matrix and determine the weight of criteria. (The sum of all the weights should be equal to 1).

STEP 2: Calculate the normalized decision matrix.

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad (1)$$

Where n_{ij} = normalized decision matrix

STEP 3: Calculate the weighted normalized decision matrix.

$v_{ij} = w_j n_{ij}$ for $i = 1, \dots, m; j = 1, \dots, n.$ (2)

Where v_{ij} = weighted normalized decision matrix; $w_j -$ the weight of the j-th criterion

STEP 4: Determine the positive ideal and negative ideal solutions.

$$V^+ = (v_1^+, v_2^+, \dots, v_n^+) = \left(\left(\max_i v_{ij} \middle| j \in I \right), \left(\min_i v_{ij} \middle| j \in J \right) \right) \quad (3)$$

$$V^- = (v_1^-, v_2^-, \dots, v_n^-) = \left(\left(\min_i v_{ij} \middle| j \in I \right), \left(\max_i v_{ij} \middle| j \in J \right) \right) \quad (4)$$

where I is associated with benefit criteria and J with the cost criteria, i = 1, …, m; j = 1, …, n.

and $V^+ =$ positive ideal solution

$V^- =$ negative ideal solution.

STEP 5: Calculate the separation measures from the positive ideal solution and the negative ideal solution.

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_i^+ \right)^2}, \ i = 1, 2, \dots, m \qquad (5)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_i^- \right)^2}, \ i = 1, 2, \dots, m \qquad (6)$$

Where $S_i^+ =$ separation measure from positive ideal solution and

$S_i^- =$ separation measure from negative ideal solution.

STEP 6: Calculate the relative closeness to the positive ideal solution.

$$P_i = \frac{S_i^-}{S_i^- + S_i^+} \qquad (7)$$

Where $P_i =$ positive ideal solution.

STEP 7: Rank the preference order.

In the Step 1 constructed the decision matrix and determined the weight of criteria, results presented in Table 2.

Table 2. Results after applying the step1 of TOPSIS method. (designed by authors)

WEIGHT	0.2	0.2	0.2	0.2	0.2
YEAR	2013	2014	2015	2016	2017
LITHUANIA	23.6	20.16	20.25	16.79	22.86
AUSTRIA	18.6	24.28	21.06	23.4	21.78
DENMARK	28.67	30.4	30.28	31.91	32.5
HUNGARY	16.27	17.34	16.11	19.72	19.92
GERMANY	13.38	13.64	13.46	17.34	22.02
SUM	100.52	105.82	101.16	109.16	119.08

In Table 2 it was given an equal weightage to every country as the total weight should be 1. So here weight for evey country is 2.

Step 2, calculated the normalized decision matrix and results presented in Table 3.

Table 3. Results after applying the step 2 of TOPSIS method. (designed by authors)

WEIGHT	0.2	0.2	0.2	0.2	0.2
YEAR	2013	2014	2015	2016	2017
LITHUANIA	0.506780217	0.410930041	0.430639773	0.33332484	0.421969
AUSTRIA	0.399411527	0.494909792	0.447865364	0.464550402	0.402034
DENMARK	0.615652068	0.619656412	0.643939374	0.633495869	0.599912
HUNGARY	0.349377717	0.353448756	0.342597864	0.391492903	0.3677
GERMANY	0.287318614	0.278030048	0.286242535	0.34424376	0.406464

In Table 3 was calculated normalized decision matrix, and presented results of each country from year 2013 to 2017.

Step 3, calculated the weighted normalized decision matrix, results presented in Table 4.

Table 4. Results after applying the step3 of TOPSIS method. (designed by authors)

YEAR	2013	2014	2015	2016	2017
LITHUANIA	0.101356043	0.082186008	0.086127955	0.066664968	0.084394
AUSTRIA	0.079882305	0.098981958	0.089573073	0.09291008	0.080407
DENMARK	0.123130414	0.123931282	0.128787875	0.126699174	0.119982
HUNGARY	0.069875543	0.070689751	0.068519573	0.078298581	0.07354
GERMANY	0.057463723	0.05560601	0.057248507	0.068848752	0.081293

In Table 4 presented numbers after calculating the weighted normalized decision matrix. Multiply the columns of normalized decision matrix by the associated weights from entropy method. The weighted and normalized decision matrix is obtained.

Step 4, determined the positive ideal and negative ideal solutions, results presented in Table 5.

Table 5: Results after applying the step4 of TOPSIS method. (designed by authors)

V+	0.123130414	0.123931282	0.128787875	0.126699174	0.119982
V-	0.057463723	0.05560601	0.057248507	0.066664968	0.07354

In Table 5 presented positive and negative ideal solutions for the statistics. These results obtained after comparing all countries data.

Step 5, calculated the separation measures from the positive ideal solution and the negative ideal solution, results presented in Table 6.

Table 6: Results after applying the step 5 of TOPSIS method. (designed by authors)

Si+	Si-
0.094379	0.059874
0.082089	0.064536
0	0.140923
0.117484	0.025376
0.13763	0.008054

In Table 6 it was calculated sparation measures from positive ideal solutions and negative ideal solutions the content of ideal and nadir ideal, distances of each alternative from the ideal and nadir for our problem, and the relative closeness to the ideal solution.

Step 6 results presented in Table 7.

Table 7: Results after applying the step6 of TOPSIS method. (designed by authors)

Pi
0.388154
0.440143
1
0.177629
0.055287

In Table 7, after calculations established relative closeness to the positive ideal solution.

Step 7, calculated the rank of the preference order results presented in Table 8.

Table 8: Results after applying the step7 of TOPSIS method. (designed by authors)

	2013	2014	2015	2016	2017	si+	si-	pi	Rank
LITHUANIA	0.101356043	0.082186008	0.086127955	0.066664968	0.084394	0.094379	0.059874	0.388154	3
AUSTRIA	0.079882305	0.098981958	0.089573073	0.092910 08	0.080407	0.082089	0.064536	0.440143	2
DENMARK	0.123130414	0.123931282	0.128787875	0.126699 174	0.119982	0	0.140923	1	1
HUNGARY	0.069875543	0.070689751	0.068519573	0.078298 581	0.07354	0.117484	0.025376	0.177629	4

GERMANY	0.057463723	0.05560601	0.057248507	0.068848752	0.081293	0.13763	0.008054	0.055287	5

In Tabale 8 presented rank of each country according to ICT usage. Lithuanian rank is 3 among 5 analysed countries. Better position has Denmark and Austria, Hungary and Germany following Lithuania.

2.2 Evaluation using SAW method

Simple Additive Weighting method is often also known as weighted summing method. The basic concept of SAW method is to find the weighted sum of performance ratings on each alternative on all attributes (Deni et all., 2013). The SAW method requires the process of normalizing the decision matrix to a scale comparable to all existing alternative ratings.

The SAW method is carried out as follow:

STEP 1: Construct the decision matrix and determine the weight of criteria. (The sum of all the weights should be equal to 1).

STEP 2: Calculate the normalized decision matrix.For minimum criteria

$$\bar{r}_{ij} = \frac{\min_j r_{ij}}{r_{ij}} \qquad (8)$$

r_{ij} – i-th criterion's value for j-th alternative.

$\min_j r_{ij}$ – the smallest i-th criterion's value for all the alternatives compared.

$\bar{r}_{ij}$ – denotes the converted values. For maximum criteria

$$\bar{r}_{ij} = \frac{r_{ij}}{\max_j r_{ij}} \qquad (9)$$

$\max_j r_{ij}$ – the largest i-th criterion's value of all alternatives.

STEP 3: Calculate the weighted normalized decision matrix.

$$w_i * \bar{r}_{ij} \qquad (10)$$

w_i – weight of the i-th criterion

$\bar{r}_{ij}$ – normalized i-th criterion's value for j-th object; $i = 1, \dots, m; j = 1, \dots, n$

m – the number of the criteria used

n – is the number of the objects (alternatives) compared.

STEP 4: Calculate the sum.

$$S_j = \sum_{i=1}^{m} w_i \bar{r}_{ij} \quad (11)$$

STEP 5: Rank the preference order.

The one of the limitations of the SAW method is all the criteria must be positive so if we have the negative values they should be transferred to the positive values. The transformation can be done as follow:

$$\bar{r}_{ij} = r_{ij} + \left|\min_j r_{ij}\right| + 1 \quad (12)$$

Step 1 results presented in Table 9.

Table 9: Results after applying the step1 of SAW method. (designed by authors)

	MAX	MAX	MAX	MAX	MAX
WEIGHT	0.2	0.2	0.2	0.2	0.2
YEAR	2013	2014	2015	2016	2017
LITHUANIA	23.6	20.16	20.25	16.79	22.86

AUSTRIA	18.6	24.28	21.06	23.4	21.78
DENMARK	28.67	30.4	30.28	31.91	32.5
HUNGARY	16.27	17.34	16.11	19.72	19.92
GERMANY	13.38	13.64	13.46	17.34	22.02

The comparison matrix is shown in Table 9, indicating the relative importance of the criterion in the compared to the criterion in the rows. Here were taken maximum criteria.

Step 2, calculated the normalized decision matrix and results presented in Table 10.

Table 10: Results after applying the step2 of SAW method. (designed by authors)

	MAX	MAX	MAX	MAX	MAX
WEIGHT	0.2	0.2	0.2	0.2	0.2
YEAR	2013	2014	2015	2016	2017
LITHUANIA	0.82316	0.663158	0.668758	0.526167	0.703385
AUSTRIA	0.648762	0.798684	0.695509	0.733312	0.670154
DENMARK	1	1	1	1	1
HUNGARY	0.567492	0.570395	0.532034	0.617988	0.612923
GERMANY	0.46669	0.448684	0.444518	0.543403	0.677538

In table 10 presented results after calculating the normalized decision matrix.

Step 3, calculated the weighted normalized decision matrix, results presented in Table 11.

Table 11: Results after applying the step 3 of SAW method. (designed by authors)

	MAX	MAX	MAX	MAX	MAX
WEIGHT	0.2	0.2	0.2	0.2	0.2
YEAR	2013	2014	2015	2016	2017
LITHUANIA	0.164632	0.132632	0.133752	0.105233	0.140677
AUSTRIA	0.129752	0.159737	0.139102	0.146662	0.134031
DENMARK	0.2	0.2	0.2	0.2	0.2
HUNGARY	0.113498	0.114079	0.106407	0.123598	0.122585
GERMANY	0.093338	0.089737	0.088904	0.108681	0.135508

In table 11 presented result after calculating the weighted normalized decision matrix.This table illustrates the effect of weights on the normalized matrix by multiplying the acquired weight vector from BWM on the decision making matrix.

Step 4, calculated the sum, result presented in Table 12.

Table 12 - Results after applying the step4 of SAW method. (designed by authors)

	MAX	MAX	MAX	MAX	MAX	SUM
WEIGHT	0.2	0.2	0.2	0.2	0.2	

YEAR	2013	2014	2015	2016	2017	
LITHUANIA	0.164632	0.132632	0.133752	0.105233	0.140677	0.676926
AUSTRIA	0.129752	0.159737	0.139102	0.146662	0.134031	0.709284
DENMARK	0.2	0.2	0.2	0.2	0.2	1
HUNGARY	0.113498	0.114079	0.106407	0.123598	0.122585	0.580166
GERMANY	0.093338	0.089737	0.088904	0.108681	0.135508	0.516167

The Table 12 represents the outcomes subsequent to computing the sum of each country for every year.

Step 5, ranked the preference order, results presented in Table 13.

Table 13. Results after applying the step 5 of SAW method. (designed by authors)

	MAX	MAX	MAX	MAX	MAX	SUM	RANK
WEIGHT	0.2	0.2	0.2	0.2	0.2		
YEAR	2013	2014	2015	2016	2017		
LITHUANIA	0.164632	0.132632	0.133752	0.105233	0.140677	0.676926	3
AUSTRIA	0.129752	0.159737	0.139102	0.146662	0.134031	0.709284	2
DENMARK	0.2	0.2	0.2	0.2	0.2	1	1
HUNGARY	0.113498	0.114079	0.106407	0.123598	0.122585	0.580166	4
GERMANY	0.093338	0.089737	0.088904	0.108681	0.135508	0.516167	5

The Table 13 demonstrates the position of every nation as per the use of ICT in all organizations from 2013 to 2017. Lithuanian rank is 3 among 5 analysed countries.All the countries are relatively close to each other.

From the results it is observed that Lithuania, Astria, Denmark, Hungary and Germany obtained the relative closeness to ideal solution and the ranks are 3, 2, 1, 4, and 5 respectively. The Denmark is identified as the best country for ict usage among the considered ones which has the best relative closeness value. TOPSIS and SAW is applied to achieve final ranking preferences in descending order; thus allowing relative performances to be compared.

Conclusions

Information and communication technologies (ITC) directly responsible for grow of virtual business. Subsequent to investigating the insights and utilizing the two strategies (TOPSIS and SAW), we can see which nation has the best ICT use and access in all organizations (10 people utilized or more) for as far back as 5 years and we can likewise observe which nation positions first in ICT use and access. From the practical result of the two analysis we can see that Denmark stands first, Lithuania stands third, Austria stands second, Hungary stands fourth and Germany stands fifth as per the ICT utilization and access in virtual business. By the assessment of ICT utilization in Lithuania in correlation with alternate nations, we can know how Lithuania has a feasible advancement in all organizations by actualizing ICT in little and medium measured ventures. The exact research demonstrates that we can assess nations by ICT use in organizations by applying the multicriteria basic leadership strategies. The constraint of this exploration is, that wehre examined just five nations since we couldn't locate the entire insights and we utilized just two multicriteria basic leadership strategies (TOPSIS and SAW) in light of the fact that there are no master assessments for these measurements. This exploration could help to form strategies of increasing ICT usage in Lithuania and encourage the grow virtual business.

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