

LEED Empirical Evidence in Northern and Southern Europe

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Abstract—The Leadership in Energy and Environmental Design (LEED) green building rating system is recognized in Europe. LEED uses regional priority (RP) points that are adapted to different environmental conditions. However, the appropriateness of the RP points is still a controversial question. To clarify this issue, two different parts of Europe: northern Europe (Finland and Sweden) and southern Europe (Turkey and Spain) were considered. Similarities and differences in the performances of LEED 2009-new construction (LEED-NC 2009) in these four countries were analyzed. It was found that LEED-NC 2009 performances in northern and southern parts of Europe in terms of Sustainable Sites (SS), Water Efficiency (WE), Materials and Resources (MR), and Indoor Environmental Quality (EQ) were similar, whereas in Energy and Atmosphere (EA), their performances were different. WE and SS revealed high performances (70-100%); EA and EQ demonstrated intermediate performance (40-60%); and MR displayed low performance (20-40%). It should be recommended introducing the following new RP points: for Turkey - water-related points and for all four observed countries - green power-related points for improving the LEED adaptation in Europe.

Keywords—Green building, Europe, LEED, regional priority points.

I. INTRODUCTION

GREEN building schemes are country-dependent standards that help in the design and construct of buildings according to local geography and climate, cultural and demographic issues, available natural resources, and country-prevailing building technologies [1]. In addition to other green rating schemes, the well-known schemes are Green Star (in Australia), Building Research Establishment Environmental Assessment Method (BREEAM) (in the UK), the DGNB sustainable building certification system (in Germany), the Comprehensive Assessment System for Built Environment Efficiency (CASBEE) (in Japan), and LEED (in the US).

In this study, the LEED scheme was the focus due its wide acceptance around the world. For example, Wu et al. [2], who analyzed 3,416 LEED-NC 2009 projects, reported that the projects were certified in the US, China, Turkey, Brazil, Chile, Germany, and others. In this respect, LEED 2009 was the first version that in addition to five basic categories, SS, WE, EA, MR, and Indoor EQ, included a RP category with four bonus points [3]. These points are supposed to be used to adapt LEED to local conditions of other countries [4]. The RP credits that were suggested by the US Green Building Council (USGBC) for many countries around the world can be found on the USGBC website [5]. However, these suggested RP

credits have caused much discussion and criticism regarding their appropriateness for countries that previously used them. In this respect, mostly qualitative analyses have been presented [6]-[9]. Neama [6] studied the application of the LEED and Green Pyramid (local Egyptian green rating scheme) in the Middle East. As a result, Green Pyramid was named the most appropriate scheme for this region due to its more appropriate approach to solve problems of local resources, such as water stress, and to use available solar energy. Other authors, however, reported successful applications of LEED in foreign countries such as Chile, Colombia, the Czech Republic, Netherlands, Sweden, the United Arab Emirates [7], India and Turkey [8]. Additionally, LEED-new construction (NC) RP credits for Canada, Turkey, China, and Egypt were analyzed by Suzer [9], who concluded and suggested that USGBC RP credits for these countries do not reflect specific local issues. The author claimed that no water-related credits were revealed for Turkey despite high water stress due to likely future global warming that was predicted for this country. In addition, Suzer [9] reported that only one sustainable city-relevant RP credit was revealed for China despite this country having a high-density population.

Wu et al. [2] confirmed quantitatively the claim that RP credits suggested by USGBC, in general, are not appropriate for foreign countries. The authors studied LEED-NC 2009 certified projects in China, Turkey, and Brazil. As a result, many unpopular RP credits in these countries were reported. For China, Quantity Control in Stormwater Design (SSc6.1) was the most unpopular RP credit, only 6.5% of the total projects received this credit; and Enhanced Commissioning (EAc3) was accepted with low popularity, and only 29.4% of the total projects received this credit. In Turkey, the popularity of the RP credits was even lower, and Construction Waste Management (MRc2) may help LEED experts improve further versions of LEED schemes by developing more applicable basic categories generally and, in particular, prescribing more correct local RP for northern and southern Europe (Europe is of specific interest because different attitudes to building energy savings were revealed in its different parts [10]) toward more adjustable green building in these parts of Europe.

II. MATERIALS AND METHODS

A. Design of the Study

The present study considers two kinds of design structures: a split-unit design or nested (hierarchical) design a single-unit design [11]. In this respect, Europe is the sampling frame. Northern Europe and southern Europe are the two primary sampling units. Finland and Sweden are two subunits that are

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nested into northern Europe. Turkey and Spain are two subunits that are nested into southern Europe.

LEED data (all credits in SS, WE, EA, MR, and EQ categories) are related to the ordinal scale. Therefore, a single-unit design structure (i.e., a comparison between Finland vs. Sweden or Turkey vs. Spain) and a non-parametric Wilcoxon–Mann–Whitney (WMW) test [12] were used.

B. Data Collection

LEED-NC 2009 projects that were certified in Finland, Sweden, Turkey, and Spain were analyzed. For this analysis, from the USGBC website new construction directory [13], USGBC scorecards of all the available projects in these countries as of May 2018 were downloaded. From the scorecards, all required information and the credits awarded points in the five main categories—SS, WE, EA, MR, and EQ—were collected. Then, the RP points were also collected and redistributed among the five relevant main categories.

C. Statistical Analysis

An interval data scale: descriptive statistics (the mean±standard deviation [SD]) and a parametric two-stage nested ANOVA test were applied. An ordinal data scale: descriptive statistics (the median±interquartile range [IQR, 25th–75th percentile]) and the extract significant WMW test were applied. Paired comparison unpaired groups: a non-parametric effect size (Cliff's δ) was applied. Cliff's [14, p. 495] is expressed as:

$$\delta = \#(x_1 > x_2) - \#(x_1 < x_2) / (n_1 n_2)$$

where x_1 and x_2 are scores within group 1 and group 2, respectively; n_1 and n_2 are the sizes of the sample groups, group 1 and group 2, respectively; and # indicates the number of times.

Cliff's δ ranges between - 1 and + 1; positive (+) values: group 1 is larger than group 2, 0 values: equality or overlap, and negative (-) values: group 2 is larger than group 1 [14]. The effect size is (i) negligible: if $|\delta| < 0.147$, (ii) small: if $0.147 \leq |\delta| < 0.33$, (iii) medium: if $0.33 \leq |\delta| < 0.474$, or (iv) large: if $|\delta| \geq 0.474$ [15].

P-value (P) was used to conclude: (1) the difference between two countries seems to be positive (i.e., there seems to be a difference between two countries), (2) the difference between two countries seems to be negative (i.e., there does not seem to be a difference between two countries), or (3) judgment is suspended regarding the difference between two countries. It should be noted that a “three-valued logic” interpretation should be made without reference to a specified α , without use of ‘significant’ and ‘non-significant’ terms, and without any post hoc corrections of Type I errors [16], [17].

III. RESULTS AND DISCUSSION

A. SS Category

Table I, in both northern and southern European countries, 12 SS credits were performed in a similar way and only two credits were performed in a different way.

Similar high performances were noted for SSc1 Site Selection, SSc2 Development Density and Community Connectivity, SSc4.1-4.4 Alternative Transportation (Public Transportation Access, Bicycle Storage and Changing Rooms, Low-Emitting and Fuel-Effective Vehicles, and Parking Capacity), SSc5.2 Site Development—Maximize Open Space, and SSc7.1 Heat Island Effect—Nonroof. Similar low performances were noted for SSc3 Brownfield Redevelopment, SSc5.1 Site Development—Protect or Restore Habitat, SSc6.2 Stormwater Design—Quality Control, and SSc8 Light Pollution Reduction.

However, in improving onsite stormwater and installing cool white collar roofs and vegetated roofs, Turkey performed better than Spain, which may be because in the two southern Europe countries, only Turkey has RP points for SSc6.1 Stormwater Design—Quantity and Control and SSc7.2 Heat Island Effect—Roof. However, the opposite was also noted. For example, considering the two northern Europe countries, only Finland has RP points for SSc6.1; however, both Finland and Sweden performed worst in terms of this credit. An additional example is the case of SSc5.1 Site Development—Protect or Restore Habitat. In SSc5.1, Finland and Sweden have RP points; however, the countries' performances were similarly low in the credit.

B. WE Category

Table II. In WEc1 Water Efficient Landscaping, the four countries performed high but differently, although only Spain has RP points in this credit. Sweden's performance was better than Finland's, and Spain's performance was better than Turkey. In WEc3 Reducing Water Use, Finland performed higher than Sweden despite that Sweden only having RP points for this credit, whereas due to its RP points, Spain performed higher than Turkey. Similar high performances were revealed only for WEc2 Innovative Wastewater Technologies (WEc2), while only one of the countries, Spain, has RP points in this credit.

It should be noted that for Spain, RP points are redistributed eventually through all three WE credits. However, for Turkey, currently only the WEc2 credit has a RP point. Therefore, it is also suggested to add RP bonus points in two additional WE credits, WEc1 and WEc3, for this country.

C. EA Category

Table III. In the northern and southern European countries, similar high performances were noted for EAc4 Enhanced Refrigerant Management, whereas similar low performances were noted for EAc2 On-site Renewable Energy and EAc6 Green Power. It should be noted that only EAc2 has RP points for all those countries. Thus, to encourage renewable applications in Finland, Sweden, Turkey, and Spain, RP points should also be charged for EAc6.

Analyzing the EAc1 results, all four countries have RP points in this credit. However, the performances of the two northern European countries were twice (approximately 90–105%) the performances of the two southern European countries (approximately 40–50%). In this respect, the

performances of Turkey and Spain confirm the results presented by Wu et al. [2], who evaluated overall LEED-NC 2009 projects certified in the US and through the world.

D.MR Category

Table IV. In the northern and southern European countries, seven MR credits were performed in a similar way (MRc2 Construction Waste Management and MRc5 Regional Materials - similar high performances and MRc1.1 and MRc1.2 Building Reuse (Maintain Existing Walls, Floors and Roof and Maintain Existing Interior Nonstructural Elements), MRc3 Materials Reuse, MRc6 Rapidly Renewable Materials, and MRc7 Certified Wood – similar low performances), whereas one credit was performed in a different way (MRc4 Recycled Content).

It should be mentioned that MR is a well-known low-performance category. This is due to difficulty in using of reused or recycled materials [2], [18]. Such results were reported by others researchers for LEED-NC 2009 projects certified in the US [2]. Thus, LEED experts should be focused on representation of those difficult MR credits.

E. EQ Category

Table V. In the northern and southern European countries, 13 EQ credits performed in a similar way, whereas two credits performed in a different way. EQc2 Increased Ventilation, EQc3.1 and EQc3.2 Construction Indoor Air Quality (IAQ) Management plan (During Construction and Before Occupancy), EQc4.1 and EQc4.2 Low-Emitting Materials (Adhesives and Sealants; Paints and Coatings), EQc6.1 Controllability of Systems—Lighting, EQc7.1 and EQc7.2 Thermal Comfort (Design and Verification) were performed similarly high. EQc4.3 and EQc4.4 Low-Emitting Materials (Flooring Systems and Composite Wood and Agrifiber Products), EQc6.2 Controllability of Systems—Thermal Comfort, EQc8.1 and EQc8.2 Daylight and Views (Daylight

and Views) were performed similarly low. Thus, EQ can be characterized as intermediate-performance category, in which approximately half of the EQ credits were performed similarly high. Such results were reported by others researchers for LEED-NC 2009 projects certified in the US [2], [18].

IV. CONCLUSIONS

In this study, LEED-NC 2009 projects certified in northern and southern European countries such as Finland and Sweden and Turkey and Spain were under consideration. In the northern and southern European groups of countries, similar and different category performances were revealed.

In the SS, MR, and EQ categories, the following credits performed in a similar high way: (i) in the SS, density built urban environments, alternative clean transportation, and open shaded green spaces; (ii) in the MR, waste management and regional materials; (iii) in the EQ, increased ventilation, IAQ, low-emitting adhesives and paints, lighting system and thermal comfort. However, there were credits that performed in a similar low way: (i) in the SS, treatment of contaminated land, protection of existing place biodiversity, managing on-site stormwater, and decreasing external light pollution; (ii) in the MR, reusing and recycling; (iii) in the EQ, low-emitting flooring and composite wood, daylight and views. The total resulting performances (percentage of received points relative to the category total allowed points) were (i) in the SS, 70-75%, indicating a well-designed SS category; (ii) in the MR, 20-30% in northern Europe countries and 40% in southern Europe countries, suggesting the low-popular MR credits should be reconsidered for their redesign; (iii) in the EQ, 40-60% in northern Europe countries and 60-65% in southern Europe countries, demonstrating intermediate category performance.

TABLE I
SS PERFORMANCE

Credit	Pt	Finland Median±25-75%	Sweden Median±25-75%	Finland vs. Sweden P	Finland vs. Sweden δ	Turkey Median±25-75%	Spain Median±25-75%	Turkey vs. Spain P	Turkey vs. Spain δ
SSc1	1	1.0±0.0 ^a	1.0±0.0 ^a	0.420	0.13	1.0±0.0 ^a	1.0±0.0 ^a	0.367	-0.08
SSc2	5	5.0±0.0 ^a	5.0±0.0 ^a	1.000	0.04	5.0±5.0 ^a	5.0±5.0 ^a	1.000	0.00
SSc3	1	0.0±1.0 ^b	0.0±1.0 ^b	0.586	-0.14	0.0±0.0 ^b	0.0±0.0 ^b	1.000	0.00
SSc4.1	6	6.0±0.0 ^a	6.0±0.8 ^{a*}	0.140	-0.17	6.0±0.0 ^a	6.0±0.0 ^a	1.000	0.00
SSc4.2	1	1.0±0.0 ^a	1.0±0.0 ^a	1.000	0.04	1.0±0.0 ^a	1.0±0.0 ^a	0.689	0.05
SSc4.3	3	3.0±0.0 ^a	3.0±0.0 ^a	1.000	0.02	3.0±0.0 ^a	3.0±0.0 ^a	0.689	0.05
SSc4.4	2	2.0±2.0 ^a	2.0±2.0 ^a	0.899	-0.08	2.0±0.0 ^a	2.0±2.0 ^a	0.101	0.20
SSc5.1	1	0.0±0.0 ^{b*}	0.0±0.0 ^{b*}	0.980	-0.01	0.0±0.0 ^b	0.0±1.0 ^b	0.112	-0.20
SSc5.2	1	1.0±1.0 ^a	1.0±1.0 ^a	1.000	-0.03	1.0±1.0 ^a	1.0±1.0 ^a	0.416	0.12
SSc6.1	1	0.0±0.0 ^{b*}	0.0±1.0 ^b	0.379	-0.17	1.0±2.0 ^{c*}	0.0±0.0 ^c	0.001	0.44
SSc6.2	1	0.0±0.0 ^b	0.0±0.8 ^b	0.073	-0.26	0.0±1.0 ^b	0.0±0.8 ^b	0.293	0.15
SSc7.1	1	1.0±0.7 ^a	0.0±1.0 ^a	0.081	0.31	1.0±0.0 ^a	1.0±0.8 ^a	0.458	0.10
SSc7.2	1	0.0±0.0 ^b	0.0±0.8 ^b	0.279	-0.19	1.0±2.0 ^{c*}	1.0±1.0 ^c	0.002	0.42
SSc8	1	0.0±0.0 ^b	0.0±0.0 ^b	0.680	0.09	0.0±0.0 ^b	0.0±1.0 ^b	0.118	-0.18
SS	26	18.0±3.0 ^a	18.0±3.0 ^a	0.923	-0.02	20.0±4.0 ^a	18.0±5.8 ^a	0.045	0.28

^aSimilar high performances, ^bsimilar low performances, ^cdifferent performances. *Credit, which has a RP bonus point. The P values: bold font—seems to be positive, ordinal font size—seems to be negative, italic font—judgment is suspended.

TABLE II
WE PERFORMANCE

Credit	Pt	Finland Median±25-75%	Sweden Median±25-75%	Finland vs. Sweden P	Finland vs. Sweden δ	Turkey Median±25-75%	Spain Median±25-75%	Turkey vs. Spain P	Turkey vs. Spain δ
WEc1	4	4.0±4.0 ^c	5.0±1.0 ^c	0.013	-0.47	4.0±3.0 ^c	5.0±1.5 ^{c*}	0.003	-0.39
WEc2	2	3.0±1.0 ^a	3.0±1.0 ^a	0.839	0.04	2.0±1.0 ^a	3.0±3.0 ^{a*}	0.134	-0.20
WEc3	4	4.0±1.0 ^c	2.0±4.0 ^{c*}	0.028	0.41	4.0±1.0 ^c	5.0±0.0 ^{c*}	0.001	-0.58
WE	10	8.0±3.0 ^a	8.0±2.0 ^a	0.732	-0.07	10.0±3.0 ^c	12.0±4.5 ^c	0.003	-0.39

^aSimilar high performances, ^bsimilar low performances, ^cdifferent performances. *Credit, which has a RP bonus point. The P values: bold font—seems to be positive, ordinal font size—seems to be negative, italic font—judgment is suspended.

TABLE III
EA PERFORMANCE

Credit	Pt	Finland Median±25-75%	Sweden Median±25-75%	Finland vs. Sweden P	Finland vs. Sweden δ	Turkey Median±25-75%	Spain Median±25-75%	Turkey vs. Spain P	Turkey vs. Spain δ
EAc1	19	17.0±7.0 ^{a*}	20.0±3.0 ^{a*}	0.055	-0.36	8.0±4.0 ^{b*}	9.0±9.0 ^{b*}	0.676	-0.06
EAc2	7	0.0±0.0 ^{b*}	0.0±0.0 ^{b*}	0.250	0.16	0.0±2.0 ^{b*}	0.0±0.0 ^{b*}	0.248	0.13
EAc3	2	2.0±2.5 ^c	0.0±2.0 ^c	0.004	0.38	0.0±2.0 ^c	2.0±2.5 ^{c*}	0.004	-0.37
EAc4	2	2.0±0.0 ^a	2.0±2.0 ^a	0.057	0.32	2.0±0.0 ^a	2.0±2.0 ^a	0.273	0.14
EAc5	3	2.0±2.7 ^a	3.0±4.0 ^a	0.232	-0.22	3.0±0.0 ^c	3.0±2.0 ^c	0.005	0.35
EAc6	2	0.0±2.0 ^b	0.0±0.0 ^b	0.396	0.18	0.0±0.0	0.0±0.0	1.000	0.02
EA	35	22.0±5.8	23.0±2.8	0.359	-0.18	15.0±7.0	15.0±9.5	0.883	0.02

^aSimilar high performances, ^bsimilar low performances, ^cdifferent performances. *Credit, which has a RP bonus point. The P values: bold font—seems to be positive, ordinal font size—seems to be negative, italic font—judgment is suspended.

TABLE IV
MR PERFORMANCE

Credit	Pt	Finland Median±25-75%	Sweden Median±25-75%	Finland vs. Sweden P	Finland vs. Sweden δ	Turkey Median±25-75%	Spain Median±25-75%	Turkey vs. Spain P	Turkey vs. Spain δ
MRc1.1	3	0.0±1.5 ^b	0.0±0.0 ^b	0.157	0.21	0.0±0.0 ^b	0.0±1.5 ^b	0.003	-0.23
MRc1.2	1	0.0±0.0 ^b	0.0±0.0 ^b	1.000	0.00	0.0±0.0 ^{b*}	0.0±0.0 ^b	1.000	0.01
MRc2	2	2.0±0.8 ^a	2.0±0.0 ^a	0.616	-0.09	2.0±1.0 ^a	2.0±0.8 ^a	0.870	-0.03
MRc3	2	0.0±0.0 ^b	0.0±0.0 ^b	1.000	0.00	0.0±0.0 ^b	0.0±0.0 ^b	1.000	-0.02
MRc4	2	0.0±0.0 ^c	1.0±1.0 ^c	0.005	-0.50	2.0±0.0 ^c	1.0±1.8 ^c	0.001	0.42
MRc5	2	2.0±2.0 ^{a*}	2.0±2.0 ^a	0.872	0.04	2.0±0.0 ^a	2.0±0.0 ^a	0.141	0.11
MRc6	1	0.0±0.0 ^b	0.0±0.0 ^b	1.000	0.00	0.0±0.0 ^b	0.0±0.0 ^b	0.110	0.14
MRc7	1	0.0±0.0 ^b	0.0±0.0 ^b	1.000	0.00	0.0±0.0 ^b	0.0±0.0 ^b	0.111	-0.33
MR	14	3.0±3.0 ^b	4.0±3.0 ^b	0.682	-0.08	6.0±1.0 ^b	6.0±2.0 ^b	0.641	-0.06

^aSimilar high performances, ^bsimilar low performances, ^cdifferent performances. *Credit, which has a RP bonus point. The P values: bold font—seems to be positive, ordinal font size—seems to be negative, italic font—judgment is suspended.

TABLE V
EQ PERFORMANCE

Credit	Pt	Finland Median±25-75%	Sweden Median±25-75%	Finland vs. Sweden P	Finland vs. Sweden δ	Turkey Median±25-75%	Spain Median±25-75%	Turkey vs. Spain P	Turkey vs. Spain δ
EQc1	1	1.0±1.0 ^c	0.0±0.9 ^c	0.008	0.34	0.0±1.0 ^c	1.0±1.0 ^c	0.004	-0.37
EQc2	1	1.0±0.0 ^a	1.0±0.8 ^a	0.279	0.19	1.0±1.0 ^a	1.0±0.0 ^a	0.046	-0.23
EQc3.1	1	1.0±0.0 ^a	1.0±0.0 ^a	1.000	0.04	1.0±0.0 ^a	1.0±0.0 ^a	1.000	-0.02
EQc3.2	1	1.0±1.0 ^a	1.0±0.7 ^a	0.426	0.19	1.0±1.0 ^a	1.0±0.8 ^a	0.131	-0.20
EQc4.1	1	0.0±1.0 ^a	1.0±1.0 ^a	0.793	-0.10	1.0±0.0 ^a	1.0±1.0 ^a	0.061	0.23
EQc4.2	1	1.0±0.0 ^a	1.0±0.8 ^a	0.604	0.13	1.0±0.0 ^a	1.0±0.0 ^a	0.293	0.09
EQc4.3	1	0.0±1.0 ^b	0.0±0.0 ^b	0.058	0.31	0.0±1.0 ^b	0.0±1.0 ^b	0.761	-0.06
EQc4.4	1	0.0±0.0 ^b	0.0±0.0 ^b	0.680	0.09	0.0±0.0 ^b	0.0±0.0 ^b	0.483	-0.06
EQc5	1	1.0±1.0 ^c	0.0±0.0 ^c	0.015	0.45	1.0±1.0 ^a	1.0±1.0 ^a	0.756	0.06
EQc6.1	1	1.0±1.0 ^a	1.0±1.0 ^a	1.000	-0.03	1.0±1.0 ^a	1.0±1.0 ^a	1.000	-0.02
EQc6.2	1	0.0±1.0 ^b	0.0±1.0 ^b	1.000	0.01	0.0±1.0 ^b	0.0±1.0 ^b	0.526	0.10
EQ7.1	1	1.0±0.0 ^a	1.0±0.7 ^a	0.068	0.43	1.0±0.0 ^a	1.0±0.0 ^a	1.000	0.02
EQc7.2	1	1.0±0.3 ^a	1.0±0.9 ^a	0.045	0.39	1.0±2.0 ^{a*}	1.0±0.8 ^a	0.032	0.26
EQc8.1	1	0.0±1.0 ^{b*}	0.0±0.0 ^{b*}	0.276	0.19	0.0±1.0 ^b	0.0±1.0 ^b	0.157	-0.22
EQc8.2	1	1.0±1.0 ^b	0.0±1.0 ^b	0.689	0.12	0.0±1.0 ^b	1.0±1.0 ^b	0.196	-0.18
EQ	15	9.0±3.8 ^c	6.0±2.0 ^c	0.001	0.61	9.0±4.0 ^a	10.0±4.0 ^a	0.307	-0.14

^aSimilar high performances, ^bsimilar low performances, ^cdifferent performances. *Credit, which has a RP bonus point. The P values: bold font—seems to be positive, ordinal font size—seems to be negative, italic font—judgment is suspended.

In the WE category, the credits concerned with water use for outside (landscape) and inside (for a building) consumption performed in a different way, whereas credits related to the application of wastewater technologies performed in a similar way in the northern and southern European countries. It should be noted that all three credits performed well and resulted in the high category performance at approximately 70%-80%. In the southern European countries, currently only Spain has RP points for all three WE credits, thereby water performance in this country was better than that in Turkey. Thus, due to the possibility of high water stress in Turkey in the near future from global warming, it is recommended to decrease water RP points for this country.

In the EA category, three credits concerned with refrigerant management, renewable and green energies performed in a similar way, whereas three credits dealing with energy optimization, system commissioning processes and measurements and verification performed in a different way in northern and southern European countries. Among the similarly performing credits, renewable and green energy performed surprisingly low in both groups of countries despite a relatively high percentage (28-56%) of renewable power sources such as wind, solar, and hydro that are the current practice in the four countries. In addition, for these countries, only renewable credit has RP points. Thus, it is worth encouraging the use of renewable fuel sources by suggesting RP points to green power credits. Among differently performing credits, the energy optimization credit in northern European countries performed much better (90-105%) than those in southern European countries (40-50%), thereby demonstrating empirical evidence of higher environmental concern in northern Europe. Thus, the resulting EA category performances were 60-65% and 40% in northern and southern European countries, respectively.

REFERENCES

- [1] J. Faulconbridge, "Mobilising sustainable building assessment models: agents, strategies and local effects," *Area*, vol. 47, pp. 116-123, Feb. 2015.
- [2] P. Wu, Y. Song, W. Shou, H. Chi, H.Y. Chong, M. Sutrisna, "A comprehensive analysis of the credits obtained by LEED 2009 certified green buildings," *Renew. Sustain. Energy Rev.*, vol. 68, pp. 370-379, 2017.
- [3] USGBC. LEED 2009 for New Construction and Major Renovations. Available online: <https://www.usgbc.org/Docs/Archive/General/Docs8868.pdf> (accessed on 12 March 2018).
- [4] P. Wu, Y. Song, J. Wang, X. Wang, X. Zhao, Q. He, "Regional Variations of Credits Obtained by LEED 2009 Certified Green Buildings—A Country Level Analysis," *Sustainability*, vol. 10, pp.20, 2018.
- [5] USGBC 2014. US Green Building Council (USGBC). Regional Priority Credits directory. Available online: <http://www.usgbc.org/rpc> (accessed on 10 March 2018).
- [6] W. A. S. Neama, "Protect the planet through sustainability rating systems with local environmental criteria - LEED in the Middle East," *Procedia - Social and Behavioral Sciences*, vol. 68, pp. 752 – 766, 2012.
- [7] R. J. Cole, M. J. Valdebenito, "The importation of building environmental certification systems: international usages of BREEAM and LEED," *Build Res Inform*, vol. 41, pp. 662-676, 2013.
- [8] R. Komurlu, D. Arditi, A. P. Gurgun, "Applicability of LEED's energy and atmosphere category in three developing countries," *Energ Build*, vol. DEC, pp. 690-697, 2014.
- [9] O. Suzer, "A comparative review of environmental concern prioritization: LEED vs other major certification systems," *J Environ Manage*, vol. 154, pp. 266-283, MAY, 2015.
- [10] E. Heiskanen, K. Matschoss, Intelligent Energy Europe: Report on specific features of public and social acceptance and perception of nearly zero - energy buildings and renewable heating and cooling in Europe with a specific focus on the target countries, 2012, 138p.
- [11] S. H. Hurlbert, "Pseudofactorialism, response structures and collective responsibility," *Austral Ecology*, vol. 38, pp. 646-663, 2013.
- [12] H. B. Mann, D. R. Whitney, "On a test of whether one of two random variables is stochastically larger than the other," *Ann. Math. Stat.*, vol. 18, pp. 50-60, 1947.
- [13] USGBC. LEED for New Construction Projects Directory. Available online: <http://www.usgbc.org/projects/new-construction> (accessed on 10 May 2018).
- [14] N. Cliff, "Dominance statistics: Ordinal analyses to answer ordinal questions," *Psychol. Bull.*, vol. 114, pp. 494-509, 1993.
- [15] F. Zhang, A. Mockus, I. Keivanloo, Y. Zou, "Towards building a universal defect prediction model with rank transformed predictors," *Empir. Softw. Eng.*, vol. 21, pp. 2107-2145, 2016.
- [16] S. H. Hurlbert, C. M. Lombardi, "Final collapse of the Neyman-Pearson decision theoretic framework and rise of the neoFisherian," *Ann. Zool. Fenn.*, vol. 46, pp. 311-349, 2009.
- [17] S. H. Hurlbert, C. M. Lombardi, "Lopsided reasoning on lopsided tests and multiple comparisons," *Aust. N. Z. J. Stat.*, vol. 54, pp. 23-42, 2012.
- [18] S. Pushkar, O. Verbitsky, "LEED-NCv3 silver and gold certified projects in the US: An observational study," *Journal of Green Building*, vol. 13, pp. 67- 83, 2018.