FACTORS INFLUENCING LATVIAN SMALL AND MEDIUM ENTERPRISES TOWARDS ECO-INNOVATION

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Abstract. Although small and medium enterprises (SMEs) are the backbone of national economies, they face many barriers and constraints towards innovations, particularly eco-innovations. In the European Union (EU) eco-innovations had been recognized as an important contributor for sustainable and green growth. The aim of the study is two-fold: 1) to determine the main barriers of eco-innovations' development in Latvia; 2) to compare the state of the main identified barriers among the EU countries. The main barriers of eco-innovations are identified via statistical analysis of SMEs managers' attitudes, using the Eurobarometer survey questionnaire. Performing the statistical analysis two factors are extracted, which account 81.7 % of the common variance, and are indicated as the main barriers for eco-innovation. These factors are financial resources (72.3 % of total variance) and human resources (9.4 % of total variance). Latvia and Lithuania score similarly both factors, but Estonia rates the environment as the most important, leaving human resources on the second position. Using the factors as dimensions all EU countries show differences in the rates between the four clusters.

Keywords: eco-innovations, factor analysis, barriers, SMEs, survey.

Introduction

The European Union (EU) strategy and policy, which is supported by legislation package, strongly turns the economic development towards sustainability. Sustainable growth is one of the priorities of the EU strategy; and is based on three pillars: economic, environmental and social. It contains initiatives supporting the green growth (e.g., circular economy), resource efficiency, zero waste programs, including the support of eco-innovations [1-4]. The resource-efficiency is a key strategy of eco-efficiency and considerably the main target of eco-innovations [5-6].

At the same time, the measures related to the "green" development of small and medium size enterprises (SMEs), for instance "Green Action Plan for SMEs", are also created [4]. Furthermore, it is confirmed worldwide that SMEs are the economic backbone, as well as of the EU [7-8]. SMEs represent over 90 % of all EU businesses and account for two out of three jobs; and in 2014 accounted for 67 % of total employment and 58 % of total value added in the EU average (EU-28) non-financial business, but in Latvia - 79 % of total employment and 69 % of total value added [9].

Although, the common concept and definition of eco-innovation being still in the developing stage [10], the shortest and the latest version has been given by the Eco-Innovation Observatory as – "…any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle" [6]. The Eco-innovation index, which represents eco-innovation performance across the EU Member States, shows that the level of eco-innovation capacity of Latvian enterprises among the EU-28 is rather low, because Latvia is on the 20th position with the eco-innovation index 75 (EU average – 100) [11].

Despite eco-innovations are still a new area of research [12], the number of studies is growing. As both eco-innovations and SMEs are recognized as significant and important drivers in the sustainable economic development, the studies have been performed in several countries and on the EU level. Various aspects of eco-innovation development, including the determinants (drivers and barriers), have been evaluated by scholars [13-17].

However, in Latvia only a few papers are published devoted to eco-innovations. Moreover, they exclusively cover the general issues of eco-innovations [10; 18].

Therefore, the *aim* of the study is twofold: 1) to determine the main barriers of eco-innovations development in Latvia; 2) to compare the state of the main identified barriers among the EU countries.

Due to the lack of eco-innovations' statistics, especially of SMEs, the studies mainly are based on data from surveys as well as from in-depth case studies [12]. In order to determine the main barriers of eco-innovations the attitudes of SMEs' managers have been performed by analyzing the Eurobarometer survey questionnaire data. Because the accuracy of assessment and evaluations depends on the reliability and validity of the questionnaire [19-21], and suggested that the internal

consistency should be assessed by determining the degree of closeness of the covariance/correlation matrix to unidimensionality [27], the first and second hypothesis for testing:

H1: The questionnaire has an internal consistency against the sample;

H2: The questionnaire is unidimensional against the sample.

The eco-innovation index, which characterizes countries' eco-innovation performance, shows that compared to the EU average Latvia and other Baltic States significantly lag behind other EU countries [8]. In general, the eco-innovations' development barriers could be divided into categories such as political, informational, financial etc. [5; 22]. They also may include lack of capital, insufficient skills and investment; limited information, know-how and economic incentives; limited consumer and business acceptance etc., as well as attitudes of the managers and employees [6; 23]. Furthermore, informational and financial barriers are recognized as the most common in the EU to develop the eco-innovations [5]. Therefore, to reach the above stated aim of the study the following hypotheses are stated to test:

H3: The lack of financial resources is the major barrier to eco-innovations development;

H4: The lack of human resources is not a major barrier to eco-innovations development;

H5: The lack of financial and human resources to develop eco-innovations of Latvia's enterprises is rather lower than in Estonia and Lithuania while lower than in old EU Member States.

Materials and methods

The principal materials used for the studies are as follows: different sources of literature, e.g., scholars' articles, research papers and the reports of foreign and Latvian researchers, and institutions, as well as the data from the database of the Eco-innovation Observatory [11].

To perform statistical analysis the data of the Eurobarometer survey "FL315 Attitudes of European entrepreneurs towards eco-innovation" have been used. The aim of the survey was to investigate the behaviour, attitudes and expectations of entrepreneurs towards the development and uptake of eco-innovation [24]. The survey was carried out in 2011 with a random and representative stratified sample (n = 5,222) of EU-27 SMEs (10-249 employees) managers. Furthermore, specific information on both investments in eco-innovation activities and barriers to eco-innovation was included [24].

The data of the survey questionnaire have been used in the following manner: 1) to determine the number of important components or factors in multivariate settings; 2) to test unidimensionality of questionnaire scale by the Principal Components Analysis (PCA); 3) to find sampling adequacy by the Kaiser-Meyer-Olkin measure; 4) to determine optimum factors by the Cattell's scree test; 4) to perform Varimax rotations targeting to determine the factor loadings; 5) to identify the main significant factors, which are influencing the development of eco-innovations.

Investigating the unidimensionality of item response data is an essential component of construct reliability and validity [20]. A way to investigate the degree of the correlations among a set of variables is to use the Cronbach's alpha coefficient [25], which is the most common measure for internal consistency reliability [21; 26-27].

Despite some literature sources, mainly educational, recommend the common factor analysis, several scholars argue that the PCA should be used [28; 29]. The factor analysis could be preferred, because: it is the most widely applied and is more efficient [29], as well as reduces the dimensionality of a data set consisting of a large number of interrelated variables [28; 30].

The value of the Kaiser-Meyer-Olkin (KMO) measure and the results of the Bartlett's test of sphericity are suggested for testing the appropriateness of PCA [25; 31-33]. The Varimax is the most common rotation method used for the rotation of principal components, which maximizes the variance of each factor loading [31; 33].

Results and discussion

All items contribute to the reliability and construct validity of the scale as the items correlate more than 0.4 with the factors that underlie them, the Cronbach's alpha does not increase when one of the questionnaire items is deleted. This indicates that none of the items can be deleted from the

questionnaire. Thus, the stability of the questionnaire scale is even more supported. Therefore, the sample reliability estimates and the hypothesis H1 need to be accepted for the time. The questionnaire's internal consistency is excellent as the value of the Cronbach's alpha coefficient is 0.970 [34], thus exceeding the recommended 0.90 value. The results along with the questionnaire items are presented in Table 1.

Table 1

Questionnaire items, Cronbach's alpha values and initial factor loadings

Numbered questionnaire item	Cronbach's Alpha*	Factor loadings
1. Lack of funds within enterprise	0.962	0.892
2. Lack of external financing	0.962	0.913
3. Uncertain return on investment or too long payback period for eco-innovation	0.964	0.799
4. Lack of qualified personnel and technological capabilities within the enterprise	0.966	0.705
5. Limited access to external information and knowledge, including lack of well-developed technology support services	0.963	0.905
6. Lack of suitable business partners	0.964	0.816
7. Lack of collaboration with research institutes and universities	0.963	0.882
8. Uncertain demand from the market	0.962	0.872
9. Reducing material use is not an innovation priority	0.965	0.810
10.Reducing energy use is not an innovation priority	0.965	0.762
11. Technical and technological lock-ins in economy (e.g., old technical infrastructures)	0.962	0.884
12. Market dominated by established enterprises	0.963	0.875
13. Existing regulations and structures not providing incentives to eco-innovate	0.963	0.854
14. Insufficient access to existing subsidies and fiscal incentives	0.963	0.910

** Cronbach's alpha scores on the deletion of an item*

The unidimensionality of the questionnaire scale can be tested by PCA. The Kaiser-Meyer-Olkin (KMO) of sampling adequacy is rather high with KMO = 0.852. The Bartlett's test of sphericity was statistically significant with alpha = 0.000, supporting the H2: there is no correlation significantly different from 0 between the 14 variables.

As the computed chi-squared value 453.710 exceeds the critical value 114.268, the second hypothesis H2 cannot be rejected. The initial solution extracts 14 factors (components), the same as the number of variables factored. The results of PCA – number of the extracted factors, show that only two components have the eigenvalues above 1 (Table 2).

The cumulative percentage of variance explained by the first two factors is 81.7 %. In other words, 81.7 % of the common variance shared by the 14 variables can be accounted for by the 2 factors. Because, the unidimensionality could be also assessed using the ratio of the first eigenvalue to the sum of all the eigenvalues [35], the second hypothesis H2 is accepted.

Another way to determine the number of factors to extract in the final solution is the Cattell's scree plot. This is a plot of the eigenvalues associated with each of the factors extracted, against each factor. At the point that the plot begins to level off by forming an „elbow", the additional factors explain less variance than a single variable. The scree plot (Fig. 1) clearly supports the conclusion that two common factors are present. A sharp bend occurs at the third eigenvalue, reinforcing the conclusion that two common factors are present.

Table 2

Eigenvalues of 14 components and extracted factors

Component (Item)	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.127	72.3	72.3	10.127	72.3	72.3
2	1.316	9.4	81.7	1.316	9.4	81.7
3	0.787	5.6	87.4	-	-	-
4	0.430	3.1	90.4	-	-	-
5	0.368	2.6	93.1	-	-	-
6	0.233	1.7	94.7	-	-	-
7	0.216	1.5	96.3	-	-	-
8	0.165	1.2	97.4	-	-	-
9	0.117	0.8	98.3	-	-	-
10	0.083	0.6	98.9	-	-	-
11	0.059	0.4	99.3	-	-	-
12	0.048	0.3	99.6	-	-	-
13	0.030	0.2	99.8	-	-	-
14	0.022	0.2	100.0	-	-	-

One factor explains only 72.3 % of the Total Variance, and two factors are selected as suggested by eigenvalues. After Varimax rotation, all 14 variables had loadings on either of two factors exceeding the value of 0.6, which is commonly accepted as a „rule of thumb". The values of factors attributed to variables (variables with factor values over 0.6 are shown in bold) are displayed in Table 3. The explanations of factors retained vary depending on researchers' interpretations in various cases. Casually, two factors in the questionnaire scale can be associated with financial issues and human or personnel (management) issues.

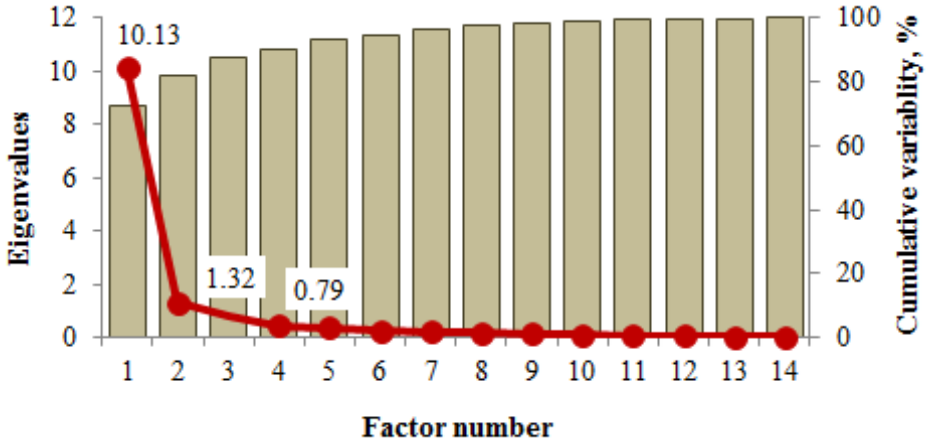

Fig. 1. **Catell's scree plot**

Several variables with higher factor loadings for the extracted Factor 1 could be attributed entirely to the financial factors (both internal and external) - lack of funds within enterprise, uncertain demand from the market, existing regulations and structures not providing incentives to eco-innovate, lack of external financing, insufficient access to existing subsidies and fiscal incentives, uncertain return on investment or too long payback period for eco-innovation, technical and technological lock-ins in economy (e.g., old technical infrastructures). Thus, the Factor 1 could be denoted or named in short form as "Financial resources". Hence, the hypothesis H3 is tested and not rejected.

Besides, our results correspond to the findings of other scholars who argue that financial barriers are critical for SMEs to develop eco-innovations [5; 36-37]

The variables associated with the production efficiency as reducing material (i.e. energy) use is not an innovation priority and would be attributed to management or human resources aspects as they are more related to the lack of knowledge, especially of top managers and leaders, as well as cost saving and policy issues.

Table 3

Rotated factor loadings of Latvian CETSCALE

Variables (Items)	Factor 1 - Financial resources	Factor 2 – Human resources
9	0.316	**0.857**
10	0.277	**0.818**
12	0.503	**0.737**
4	0.268	**0.728**
5	0.567	**0.715**
7	0.546	**0.698**
6	0.501	**0.634**
1	**0.893**	0.339
8	**0.840**	0.360
13	**0.834**	0.336
2	**0.831**	0.436
14	**0.794**	0.469
3	**0.774**	0.307
11	**0.739**	0.483

The variables such as reducing material use is not an innovation priority, reducing energy use is not an innovation priority, market dominated by established enterprises, lack of qualified personnel and technological capabilities within the enterprise, limited access to external information and knowledge, including lack of well-developed technology support services, lack of collaboration with research institutes and universities and lack of suitable business partners could clearly by attributed to internal and interpersonal as well as communication skills could be considered managerial or personnel/human resources.

We consider that such questions or variables “reducing material use is not an innovation priority” and “reducing energy use is not an innovation priority” fully correspond to the category of human resources, as reflect lack of or weak top management’s knowledge and understanding regarding the effectiveness per se and particularly the resource efficiency.

Seeking for the best suitable title or name to denote the Factor 2, we propose that possibly shorter version “Human resources” could be used.

SMEs perceive knowledge barriers as the second priority [37]. The lack or/and undeveloped knowledge, skills and behaviour of management, especially leaders [15], teams and employees are recognized as a significant barrier [7; 38-39]. Therefore, the hypothesis H4 is not fully validated and not rejected.

The results of the performed Varimax rotation - the factor scores after rotation for all EU-27 countries are plotted on a scatter diagram (Fig. 2). The scores of all countries on the scatter diagram or plot are mapped using both previously extracted factors (Financial resources and Human resources) as dimensions show differences between the four clusters of a plot.

The factor scores after Varimax rotation points to a rather distinguishable bias between the EU Northern countries and Central European countries, on the one hand, and a cluster of new EU Member states and Southern European countries, on the other hand. Besides, the latter cluster clearly suggests financial resources as a major influencing factor.

Human resources are highly rated in the Benelux countries, Portugal and German speaking countries (Germany and Austria), while financial resources are of less importance. Northern European (Scandinavian) countries, English speaking countries (UK and Ireland), France, advanced Central European countries (Czech Republic and Slovenia) consider both factors of a less importance. The environment in these countries could be considered as the most favorable. The situation is less

beneficial in the upper right cluster, where Mediterranean countries such as Italy, Spain, Greece, Cyprus and Malta regard both factors important.

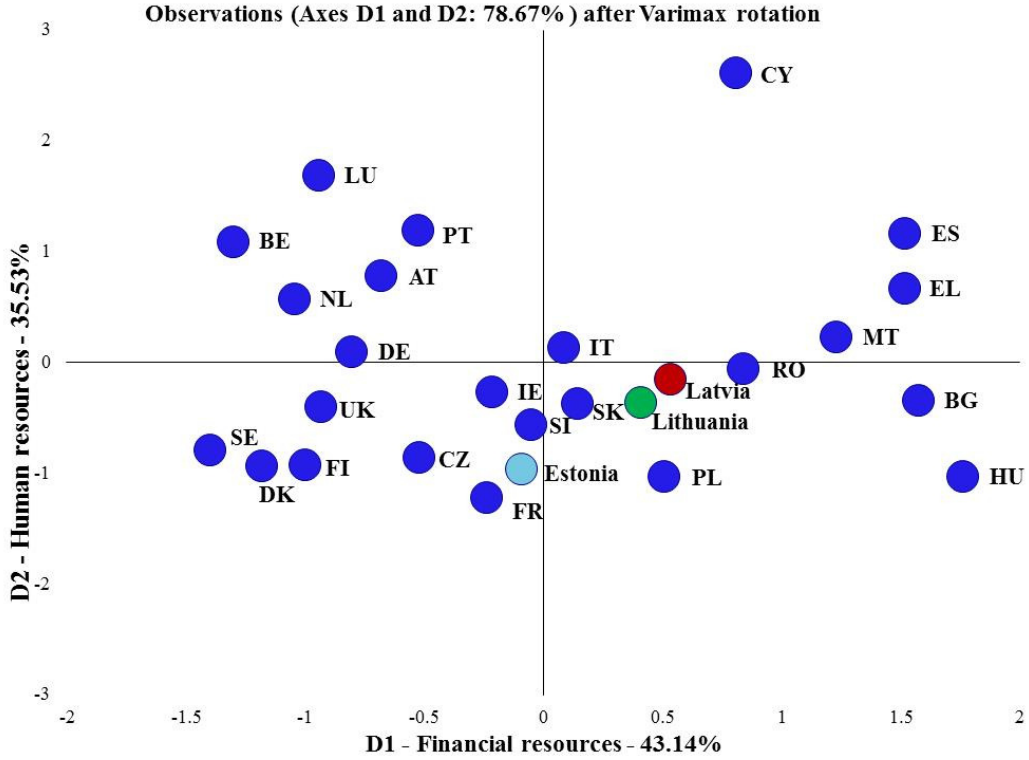

Fig. 2. **Factor scores of EU countries after Varimax rotation**

With respect to the Baltic States, Latvia and Lithuania score similarly in terms of both factors and financial resources prevail over the human resources, while Estonia rates human resources as more important. At the same time, the environment in Estonia has to be considered favorable in terms of both aspects. This finding responds to the conclusions of Horbach et al. [40] that Eastern European countries are less eco-innovative compared to the other EU countries. The hypothesis H5 is confirmed only partially, because: 1) Estonia rates human resources aspects more important among the Baltic States; 2) Latvia rates both factors higher than Lithuania.

Conclusions

The Eurobarometer survey questionnaire shows internal consistency of the scale. The uni-dimensionality of the scale is supported or rejected depending on the evaluation method selected. The questionnaire cannot be unambiguously considered as uni-dimensional.

After the Varimax rotation, the two extracted components or factors could be denoted as "Financial resources" and "Human resources", which are identified as the main barriers of eco-innovations' development. However, variables with the highest scores attributed to the factors do not allow for a marked distinction between them. Besides, it could be stressed that both factors contain a number of questions or items. Elimination of financial gaps is complicated for entrepreneurs, but to gain knowledge and skills is easier and does not require significant resources.

Evaluating the Baltic States, the results show that Latvia and Lithuania score similarly both factors – "Financial resources" and "Human resources", but Estonia rates the environment as the most important, leaving the human resources' factor on the second position.

The factor scores after Varimax rotation point to a rather distinguishable bias between the EU Northern countries and Central European countries, on the one hand, and a cluster of new EU Member states and Southern European countries, on the other hand.

Further studies could be oriented to more detailed estimation of eco-innovations' development barriers within various activity sectors, as well as for different types of eco-innovations (e.g., technological, managerial, organization etc.).

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