

The role of quality standards for chemical products existing on the markets of the European Union in development of innovative entrepreneurship

Anna Starodubova^{1,*}, Chulpan Misbakhova¹, and Nailya Gareeva²

¹Kazan National Research Technological University, Department of innovation in chemical technology, 420015, Kazan, Russia

²Kazan Innovative University named after V.G. Timiryasov, 423570, Nizhnekamsk, Russia

Abstract. The article studies the method of assessment of the impact of standards on the results of the industry: innovation, product quality, generation of waste, level of "Green Economy" and foreign trade. The approbation which has been carried out for chemical products from 26 countries of the EU in 2018 (based on the cluster analysis is given in the study). It has been concluded that the high level of coverage of standards stimulates innovation of recycling. The level of foreign trade, and the generation of waste occur regardless of the level of coverage of the standards. The high speed of implementation of the standard ensures the high level of "Green Economy". The more permanent policy of standards ensures high quality of products. Germany is the benchmark for the high level of influence of standards on the results in the chemical industry. For the rest countries of the EU, the potential of standards is not fully disclosed for reasons of insufficient coverage of standards or a large volume of waste. This assessment allows finding the benchmark of the country for study of the positive impact of standards and it helps to identify the successful strategies of standards for achieving high results in the industry.

1 Introduction

Quality standards are currently known in most countries of the world. The European Union have the largest share of the number of 50-th of most successful chemical companies in the world. It is 30% for 2018, 34% for 2017, 36% for 2016 and 32% for 2015 [1]. The remaining largest chemical companies are owned by countries: the United States, Japan, South Korea, China, Saudi Arabia, South Africa, Canada and India.

Most researchers attribute this success of the countries of EU to the role of standards in the global market. Therefore, the study of the experience of the countries of the European Union is interesting to researchers in the field of chemical products. This study is necessary for the formation of effective policies of other countries, taking into account the goals of sustainable development in the chemical industry. These goals include: improving people's welfare and ensuring social justice, reducing risks to the environment and its degradation.

The purpose of the paper is to study the standards and the results of their activities of chemical products in the European Union.

The object of the study is the activity of standardization.

The subject of this study is the standards and the results of their activities of chemical products in the European Union.

The hypothesis of the research is that a high level of coverage by standards gives more competitive advantages by stimulating innovation, high quality products on the world market. The low level of coverage by standards act the opposite way.

2 Materials and methods

One of the roles of standards is to reduce losses. This is most explored in the literature on "Lean Production". The losses are the actions that inefficiently consume resources (the overproduction, the inventory, the defects, the alteration and etc.). Reducing these losses leads to better quality. However, according to M. Imai, standards can have both a positive effect and cause deviations in processes. These deviations could be, in the following cases:

- If there was no standard;
- If you didn't follow the standard;
- If the standard was not adequate [3].

The second role of standards is to stimulate innovation. The number of researchers, as well as the European Commission, believe that the standards activate innovations related to "Sustainable development", "Green economy" and "Circular economy" [4], [5], [6], [7], [8], [9], [10]. M. Porter and C. Van der Linde believe that the right environmental have been developed standards are a source of implementation and continuous improvement of

* Corresponding author: upfr-nk@list.ru

innovations [11]. The emergence of these innovations creates prerequisites for the creation of new sectors of the economy. For example is the recycling industry. This is confirmed by the research of T. J. Lah, S. Park, M. De Bree and others [12], [13], [14].

Another group of scientists is looking at the impact of a separate REACH standard on innovation [15], [16], [17], [18], [19].

The third role of standards is to increase competitiveness in foreign markets, which is described by I. Caetano, K. Jilcha and D. Kitaw [9], [14], [20]. M. Porter and C. Van der Linde believe that in regions where the right environmental standards are introduced before others, they move to the international market before others (with high added value) [11].

According to A. Mangelsdorff and the UNIDO report, the standards act as non-tariff barriers for importing products within the WTO [21], [22]. The European Commission's Report "Impact of REACH on competitiveness, innovation and small business" surveyed respondents, among whom 67% were of the opinion that REACH does not affect their competitiveness against companies from other EU countries [10].

M. Porter emphasizes the chronological sequence of each of the three roles of the standards [11]. At the beginning of the chain, standards are developed and implemented. At the middle of the chain standards

stimulate the development of innovations. At the end of the chain implemented innovations increase competitiveness.

W. B. Gray considering that in different regions environmental norms (standards) should be implemented if the benefits to society exceed the costs of their implementation [23]. In those regions where this condition is not met, enterprises tend to move production to regions with less strict regulation [23].

The researchers also draw attention to the need for a stable and consistent state policy in the field of standards [11], [13]. M. Porter, C. Van der Linde and M. De Beers believe that it is necessary to introduce standards before other market participants.

This study consisted of the following stages.

At the first stage, the selection and classification of current standards was carried out for chemical products in the European Union, on the basis on the systematization method. The database for regional standards was the European Commission website [24], [25]. The database for international standards was the UN website, the website of the Secretariat of the Basel, Rotterdam and Stockholm Conventions, and the website of the International organization for standardization [2], [26], [27].

At the second stage of the study, the results of activities of the standards of thirist stage were selected on the basis on the expert method, as data for cluster

Table 1. The standards for chemical products of the European Union.

| The year of the publication | The name of the standard | The level of the scale of the standard |
|---|--|---|
| 1985 | The Vienna convention for the protection of the ozone layer | international |
| 1987 | The Montreal protocol on substances that deplete the ozone layer | |
| 1989 | The Basel convention on the control of transboundary movements of hazardous wastes and their disposal | |
| 1997 | The Kyoto protocol to reduce on greenhouse gas emissions | |
| 1998 | The Rotterdam convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade | |
| 2001 | The Stockholm convention on persistent organic pollutants | |
| 2006 | Commission Regulation EU 1907/2006 Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) | regional |
| | Commission Regulation EU 1013/2006, 14.06.2006 on shipments of waste | |
| 2007 | Commission Regulation EU 1272/2008 Classification, Labelling and Packaging (CLP) | international |
| | ISO 28000: 2007 Specification for security management systems for the supply chain | |
| 2010 | Commission Regulation EU 1005/09, 01.01.2010 on substances that deplete the ozone layer | regional |
| 2012 | ISO 39001: 2012 Road traffic safety management systems | international |
| 2013 | The Minamata convention to protect human health and the environment from mercury | |
| | 2015 | ISO 27001: 2013 Information security management systems |
| Sustainable development goals were adopted by the year 2030 at UN Summit | | |
| The Paris agreement to reduce CO ² emissions | | |
| ISO 9001: 2015 Quality management systems (The standard coincides with the UN sustainable development goals) | | |
| ISO 14001: 2015 Environmental management systems | | |
| Communication from the Commission to the European Parliament 614/2015 "An EU action plan for the Circular Economy" (the minimum requirements was set of the manufacturer's liability) | | |
| 2018 | Commission Regulation EU 517/2014, 01.01.2015 on fluorinated greenhouse gases | international |
| | ISO 50001: 2018 Energy management systems | |
| 2019 | ISO 45001: 2018 Occupational health and safety management systems | international |
| | Norwegian amendment to the Basel Convention of the "Partnership on plastic waste" | |

analysis for 2018. The selection of the results action of standards was based on the expert opinions of the authors M. Potter and C. Van der Linde, A. Mangelsdorf, M. De Bree.

In the third stage, all the European Union countries were ordered relative the results of activities the standards of the chemical product into uniform groups, on the basis the method of cluster analysis. The cluster analysis was carried out for 26 countries of the European Union, using the "Microsoft Office Excel" program.

3 Results

At the first stage of the study, the current standards were selected for chemical products in the European Union in 2020.

The authors classified the standards of chemical products of the European Union, according to two criteria: the level of their scale, the year of their publication. In table 1, the authors presented a classification of current standards for chemical products in the European Union for 2020.

Table 2. The level of coverage by international standards for chemical products in EU countries for 2018.

| The country | The number of certificates | | | | |
|---|----------------------------|-------------|-----------|-----------|------------|
| | ISO 9001 | ISO 14001 | ISO 27001 | ISO 45001 | ISO 50001 |
| Austria | 27 | 15 | 5 | 2 | 4 |
| Belgium | 118 | 62 | 0 | 2 | 16 |
| Bulgaria | 76 | 24 | 1 | 1 | 2 |
| Cyprus | 15 | 5 | 0 | 0 | 0 |
| Czech Republic | 128 | 53 | 1 | 0 | 0 |
| Denmark | 15 | 14 | 0 | 0 | 0 |
| Estonia | 15 | 10 | 0 | 0 | 0 |
| Finland | 7 | 4 | 0 | 6 | 5 |
| France | 24 | 15 | 0 | 3 | 14 |
| Germany | 742 | 308 | 6 | 6 | 199 |
| Greece | 166 | 56 | 1 | 0 | 9 |
| Hungary | 90 | 42 | 0 | 1 | 7 |
| Italy | 1427 | 451 | 0 | 10 | 2 |
| Latvian | 13 | 10 | 0 | 0 | 0 |
| Luxembourg | 7 | 5 | 0 | 0 | 0 |
| Malta | 2 | 1 | 0 | 0 | 0 |
| Netherlands | 87 | 24 | 0 | 2 | 0 |
| Poland | 207 | 57 | 1 | 2 | 5 |
| Portugal | 129 | 36 | 0 | 1 | 0 |
| Romania | 74 | 51 | 0 | 0 | 1 |
| Slovakia | 60 | 32 | 0 | 3 | 2 |
| Slovenia | 26 | 17 | 0 | 0 | 2 |
| Spain | 749 | 357 | 2 | 2 | 13 |
| Sweden | 40 | 30 | 0 | 0 | 1 |
| United Kingdom of GB and Northern Ireland | 131 | 56 | 0 | 2 | 6 |
| Total | 4375 | 1735 | 17 | 43 | 288 |

Authors found the number of ISO certificates issued the chemical companies in the EU in 2018 (table 2) [27]. This indicator shows the level of coverage of

international standards in the chemical industry in the European Union.

China is the leader in terms of coverage of ISO 9001, ISO 14001 "Environmental management systems", ISO 45001 "Occupational health and safety management systems" in the chemical industry in the world in 2018 [27]. Turkey ranks first in terms of coverage of ISO 27001 "Information security management systems" in the chemical industry in the world in 2018 [27]. Germany is the leader in terms of coverage of ISO 50001 "Energy management systems" in the chemical industry in the world in 2018 [27].

At the second stage of the study, the authors selected the results of international and regional standards of chemical products in the European Union for 2018 (table 3).

Table 3. The results of activity of standards for chemical products in the EU countries for 2018.

| The country | The number of innovations, patents | Green Economy Index, % | Quality Index, % | The volume of foreign trade, MEUR. | The volume of waste, thousand tons |
|---|------------------------------------|------------------------|------------------|------------------------------------|------------------------------------|
| Austria | 8.22 | 64.79 | 72 | 986 | 294 |
| Belgium | 8.91 | 57.37 | 71 | 3256 | 704 |
| Bulgaria | 0 | 40.27 | 37 | -14 | 80 |
| Cyprus | 1,5 | 45.11 | 47 | -4 | 4 |
| Czech Republic | 9.58 | 47.73 | 43 | 12 | 291 |
| Denmark | 4.65 | 68.00 | 73 | 9303 | 115 |
| Estonia | 0 | 46.62 | 46 | -2 | 695 |
| Finland | 16.46 | 69.97 | 77 | 1155 | 273 |
| France | 36.68 | 64.05 | 81 | 23837 | 1644 |
| Germany | 89.87 | 68.90 | 100 | 52048 | 3243 |
| Greece | 1 | 54.85 | 48 | -494 | 142 |
| Hungary | 1.33 | 54.19 | 45 | 698 | 184 |
| Italy | 18.91 | 56.06 | 84 | 6694 | 2628 |
| Latvia | 2.5 | 46.32 | 46 | 139 | 17 |
| Luxembourg | 2 | 52.31 | 70 | -51 | 30 |
| Malta | 1 | 51.63 | 48 | -182 | 21 |
| Netherlands | 20.9 | 59.37 | 76 | -2007 | 1115 |
| Poland | 67.4 | 41.01 | 51 | -15 | 2221 |
| Portugal | 5 | 54.05 | 54 | -200 | 239 |
| Romania | 4.5 | 47.99 | 37 | -547 | 77 |
| Slovakia | 6.2 | 45.27 | 40 | -231 | 112 |
| Slovenia | 0 | 50.58 | 40 | 500 | 64 |
| Spain | 19.82 | 54.11 | 64 | 2209 | 628 |
| Sweden | 9.81 | 76.08 | 90 | 5202 | 593 |
| United Kingdom of GB and Northern Ireland | 19.38 | 62.30 | 91 | 49206 | 1498 |

The first result of the standards is the number of patents related to recycling and secondary raw [28]. This result of chemical product standards is responsible for innovation.

The second result of the standards is the Green Economy Index [29]. This result of chemical product standards is also responsible for innovation.

The third result of the standards is the Quality Index [30]. This result of standards is responsible for the quality of chemical products. In the EU Quality Index has the score of 92 % putting it at place three worldwide (behind Germany and Switzerland). European products enjoy an above-average reputation with regard to all product attributes. Quality, technology and high safety standards are especially well-rated. Products from Germany are most often associated with the attributes of high quality (49%) and high security standards (32%) in the global comparison [30].

The fourth result of the standards is the volume of foreign trade [31]. This result of the standards is responsible for exporting and protecting against imports on the world market of chemical products.

The fifth result of the standards is the volume of chemical waste [32]. This result of the standards is responsible for the negative externalities of chemical production.

In the third stage of the study, a cluster analysis was carried out for 26 countries of the European Union. For it was using the "Microsoft Office Excel" program.

Table 4 presents the results of a cluster analysis of the role of standards for chemical product in the European Union for 2018.

Table 4. Cluster analysis of the role of standards for chemical products in EU countries.

| The country | The level, cluster | | | | | |
|---|--|------------------------------|------------------------|------------------|--------------------------------|------------------------|
| | of the coverage by international standards | of the number of innovations | of Green Economy index | of quality index | of the volume of foreign trade | of the volume of waste |
| Austria | 3 | 3 | 2 | 2 | 2 | 1 |
| Belgium | 2 | 2 | 2 | 2 | 2 | 2 |
| Bulgaria | 3 | 3 | 3 | 3 | 2 | 1 |
| Cyprus | 3 | 3 | 3 | 3 | 2 | 1 |
| Czech Republic | 2 | 2 | 2 | 3 | 2 | 1 |
| Denmark | 3 | 3 | 1 | 2 | 2 | 1 |
| Estonia | 3 | 3 | 3 | 3 | 2 | 2 |
| Finland | 3 | 2 | 1 | 2 | 2 | 1 |
| France | 3 | 2 | 2 | 2 | 2 | 2 |
| Germany | 1 | 1 | 1 | 1 | 1 | 3 |
| Greece | 2 | 3 | 2 | 3 | 2 | 1 |
| Hungary | 2 | 3 | 2 | 3 | 2 | 1 |
| Italy | 1 | 2 | 2 | 1 | 2 | 3 |
| Latvian | 3 | 3 | 3 | 3 | 2 | 1 |
| Luxembourg | 3 | 3 | 2 | 2 | 2 | 1 |
| Malta | 3 | 3 | 2 | 3 | 2 | 1 |
| Netherlands | 3 | 2 | 2 | 2 | 3 | 2 |
| Poland | 2 | 1 | 3 | 2 | 2 | 3 |
| Portugal | 2 | 3 | 2 | 2 | 2 | 1 |
| Romania | 2 | 3 | 2 | 3 | 2 | 1 |
| Slovakia | 3 | 3 | 3 | 3 | 2 | 1 |
| Slovenia | 3 | 3 | 2 | 3 | 2 | 1 |
| Spain | 1 | 2 | 2 | 2 | 2 | 2 |
| Sweden | 3 | 2 | 1 | 1 | 2 | 2 |
| United Kingdom of GB and Northern Ireland | 2 | 2 | 2 | 1 | 1 | 2 |

All data (table 2, table 3) were normalized using the Z-score method. Then the sum of the squared differences was calculated between these two data sets. Three European Union countries were selected as cluster centers. The first cluster is the country with the highest indicator level. The second cluster is a country with an average indicator level. The third cluster is the country with the lowest indicator level. Then, each indicator was compared with the minimum value for grouping countries into three clusters.

The high level of coverage of standards ensures high results of activities (the number of innovations, the Green Economy index, the quality index, the volume of export) in the chemical industry. This condition was met only for Germany, among the 26 countries of European Union in 2018 (table 4).

The average level of coverage of standards provides average results of activities (the number of innovations, the Green Economy index, the quality index, the volume of export) in the chemical industry. This condition was

met only for Belgium, among the 26 countries of European Union in 2018 (table 4).

The low coverage of standards ensures unstable results of activities (the number of innovations, the Green Economy index, the quality index, the volume of export). This condition was met for the rest 24 countries of European Union in 2018 (table 4).

Thus, the hypothesis put forward by the authors was confirmed that the high level of coverage of standards gives more competitive advantages by stimulating innovation and high quality products on the world market.

4 Discussion

The small level of coverage of standards provides protection of the domestic market from imports and promotion of exports of the European Union in the chemical industry. The low level of coverage of the standards provides the average level of foreign trade (the exports exceed the imports) in most countries of the European Union. The exceptions are Netherlands, United Kingdom, and Germany (table 4).

The level of coverage of standards has different effects on the quality index of chemical products in the European Union.

The quality index was estimated by consumers as 92% out of 100% for all countries of the European Union. This index is higher than in other countries of the world.

The large number of standards is needed to stimulate innovation to recycling in the chemical industry. However, the number of standards does not matter to stimulate environmental innovation of "Green Economy". For example, the low coverage of standards, but high Green Economy Index was in Denmark, Finland, Sweden (table 4). The speed of implementation of the standard is important. For example, Finland was one of the first countries in the world to develop the roadmap for the introduction of the Circular economy in the industry for 2016-2025.

The "Date of publication of the standard" criterion shows the speed of implementation of international standards at the regional level in the European Union (table 1). The high speed of implementation of international standards ensures the effective policy of standards in the regions. This means, that the region which was the first to implement international standards now has the competitive advantage on the global market. All international standards have analogues in the form of regional standards in the EU for 2020. REACH standard is the unique regional standard of the European Union. Other countries do not have this standard. This standard protects the European Union's chemical products on the global market. The high level of coverage of ISO 50001 "Energy management systems" is the competitive advantage of the EU in comparison with other countries in the chemical industry (table. 2).

According to M. Imai's approach to assessing standards, it can be concluded that regional and international standards have been implemented and

observed in the EU. However, the realization of the potential of standards is minimal in most countries of the EU. There are two possible reasons for this situation. The first reason is the low level of coverage of standards in EU countries (except for Spain, Italy, and Germany). The second reason is the inadequacy of standards. The high level of waste is observed concurrently with the high level of coverage of standards in the chemical industry. This situation is also typical for Germany (table 4).

In studies by other authors, the role of standards has been evaluated by results: the innovation, the quality and foreign trade. Other researchers did not include the volume of the generation of the waste in the assessment of standards. This fact is a prospect for further research.

5 Conclusion

The following conclusions were made on the evaluation of the results of the application of standards in the chemical industry of the EU.

The high level of coverage of standards ensures high the results (the number of innovations, the Green Economy index, the quality index, the volume of exports) in the industry. The average level of coverage of standards provides average results of activity (the number of innovations, the Green Economy index, the quality index, the volume of exports and the volume of waste) in the industry. The low level of coverage of standards provides unstable results of the industry.

The largest numbers of standards are needed to stimulate innovation to recycling in the chemical industry. However, the number of standards does not matter to stimulate environmental innovation in the Green Economy. It is important the speed of implementation of the standard from the international level to the regional level. For example, these are the standards of circular economy and energy management.

Unique regional standards that are not available in other countries provide the competitive advantage on the global markets. For example is the REACH standard.

The low level of coverage of the standards was found in the countries of the European Union (except for that of Spain, Italy, and Germany). The inadequacy of the standards was identified. For example, the high level of coverage of standards provides the large amount of generated waste in the chemical industry.

The practical significance of the study is the opportunity to study the successful experience of Germany in the field of standards in the chemical industry. Also, the practical significance of the study is to develop recommendations for the formation of an effective policy in the chemical industry. It is aimed at stimulating export through the international and the regional standards.

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